Physiotherapy

Imhoff · Beitzel · Stamer
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Rehabilitation in Orthopedic Surgery

- An overview of surgical procedures
- Physiotherapy
- Sports therapy

Springer

A. B. Imhoff
K. Beitzel
K. Stamer
E. Klein
G. Mazzocca
Eds.

Rehabilitation in Orthopedic Surgery

Second Edition

An overview of surgical procedures
Physiotherapy
Sports therapy

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University Prof. Andreas B. Imhoff M.D.
Hospital Rechts der Isar, Technical University of Munich, Germany

Associate Prof. Knut Beitzel, M.D. M.A. (Sport Science)
Hospital Rechts der Isar, Technical University of Munich, Germany

Knut Stamer (Physiotherapist/Osteopathist)
Medical Park Bad Wiessee St. Hubertus GmbH & Co. KG, Bad Wiessee, Germany

Elke Klein (Physiotherapist/Osteopathist)
Medical Park Bad Wiessee St. Hubertus GmbH & Co. KG, Bad Wiessee, Germany

Prof. Gus Mazzocca M.S., M.D.
University of Connecticut, Farmington, CT, USA

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Foreword

The idea for this book arose many years ago from daily cooperation with physiotherapists on patients that had recently undergone surgery. We wanted to create a tried and tested handbook that briefly presents the relevant operative and outlined steps of a surgery, as well as the major physiotherapeutic stages, in a way that is simple, understandable and demonstrated using images.

In a team of physiotherapists, ergotherapists, sports scientists, orthopedic technicians, social education workers and doctors, the courses of treatment that form understandable and comprehensible guidelines for all involved, as well as for the patients at the center of the team, must be defined. They must also continue to be useful after the time in the first surgical clinic if further treatment is to be provided in a specialized rehabilitation center or by freelance physiotherapists on an inpatient or outpatient basis. We have therefore restricted ourselves to the most important and common surgical techniques on the upper and lower extremities, as well as the spine.

Our intensive cooperation with physiotherapists and doctors from clinics in the Medical Park Group formed the foundation that we expanded into a practical handbook. Dr. Trudi Volkert, former editor at Springer publishing house, and Dr. Hubert Hörterer, former Head Physician at Medical Park St. Hubertus Clinic, again provided us with significant support at the start, and gave us the encouragement that allowed this unique work to come to life. We owe both of them our heartfelt thanks. We also received considerable support in terms of development and design from Prof. Thomas Wessinghage, current Medical Director of Medical Park Bad Wiessee St. Hubertus Clinic and his employees Knut Stamer and Elke Klein. However, the book was only made possible thanks to the generous financial contribution from Medical Park AG. The current international edition was only possible thanks to the contribution from Medi GmbH. We would also like to extend our thanks to them.

Further thanks are owed to Burkhard Schulz, the photographer, and to Kathrin Schöffmann, our model, who posed for each of the stages of physiotherapy and made them come to life over an almost endless number of sessions, as well as to Rüdiger Himmelhan for the illustrations. We would also like to thank Prof. Maximilian Rudert and Dr. Michael Ulmer, who contributed their specialist knowledge on a number of specific chapters, as well as qualified sports scientist Klaus Remuta for his assistance in creating the practical guides for stage IV.

The handbook should serve as a valuable tool, assistance, and manual for all team members supporting patients throughout the various post-surgical phases, and as a guide, without neglecting the recommendations of the surgeon and personal experience of the therapists. We are delighted to be able to present some new features as part of the second edition.

We also are very honored that Prof. Gus Mazzocca, Dr. Andreas Voss and David Lam from the University of Connecticut helped us in editing and translating the second edition of our book.

For the editors:
Andreas Imhoff and Knut Beitzel
Munich, Fall 2015

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About the Authors

University Professor Andreas B. Imhoff

is Director of the Department for Orthopaedic Sportsmedicine at University Hospital Rechts der Isar, Technical University of Munich. He is a specialist in orthopedic surgery and traumatology, as well as sports medicine.

He was until 2014 an Executive Board member of the German Society of Orthopedics and Orthopedic Surgery (DGOOC) (First Secretary to the Management Board) and on the Executive Board of the German Society for Orthopedics and Trauma (DGOU).

Prof. Andreas B. Imhoff also holds the following positions: He was a member of the board of the German-speaking Society for Arthroscopy and Joint Surgery (AGA) from 1999 to 2013, and was Congress President in 1999 and President from 2000 to 2003. He has been an honorary member since 2013. Between 2007 and 2011, he was Chairman of the program committee of the International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine (ISAKOS). He is currently an honorary member of the Arthroscopy Association of North America (AANA), honorary member of the Argentinian Shoulder Association, Corresponding Member of the Chilean Orthopedics and Trauma Association (SCHOT), Chilean Sports Orthopedic Association and American Society of Shoulder and Elbow (ASES), member of the board of trustees of the Association of Orthopaedic Research (AFOR) and board member of the German Knee Society (DKG). He also holds the Malaysian Federal Honorary Award of Darjah Kebesaran PANGLIMA JASA NEGARA (P.J.N.) "DATUK".

He is a member of the following associations: European Society of Sports Traumatology, Knee Surgery and Arthroscopy (ESSKA), Société Européenne pour la Chirurgie de l'Épaule et du Coude (SECEC), American Orthopaedic Society for Sports Medicine (AOSSM), Bayerischer Sportärzteverband (Bavarian Sports Medicine Association), Deutscher Sportärzteverband (German Sports Medicine Association), Deutsche Gesellschaft für Unfallchirurgie (German Society for Traumatology; DGU), Schweizerische Gesellschaft für Orthopädie (Swiss Orthopedics Assocation; SGO), Deutsche Vereinigung für Schulter und Ellenbogen (German Association for Shoulders and Elbows; DVSE).

Prof. Andreas B. Imhoff is Editor in Chief for the Zeitschriften für Arthroskopie (Springer) and Operative Orthopädie und Traumatologie (Springer), and is also Assistant Editor of the Journal for Shoulder and Elbow Surgery (Elsevier) and the American Journal of Sports Medicine (AJSM). In addition, he is a consultant for the following journals: Sportorthopädie/Sporttraumatologie (Springer), Deutsche Zeitschrift für Sportmedizin, Archives of Orthopaedic and Trauma Surgery (Springer), European Journal of Trauma and Emergency Surgery (Springer), Operative Techniques in Orthopaedics (Elsevier), Knee Surgery, Sports Traumatology, Arthroscopy (Springer).

Prof. Andreas B. Imhoff has received the following awards: Instructor in arthroscopic surgery AGA 1990, ASG Travelling Fellowship (USA, Canada and England) 1991, AGA Scientific Prize 1993, Education and Research Prize – Fellowship USA der AGA 1994/1995, Kappa Delta Young Investigator Award (AAOS/ORS) 1996, TUM nomination for the Leibnitz prize 2001, Scientific prize from the Association for Orthopaedic Research (AFOR) 2002, Center of Excellence 'Best Care' DKV 2002–2014, accreditation by the American Orthopaedic Academy AOA and ISAKOS as a teaching hospital since 1997. AGA-medi Award 2013: Structural and Biomechanical Changes in Shoulders of Junior Javelin Throwers – A Multimodal Evaluation as a Proof of Concept for a Preventive Exercise Protocol.

Associate Professor Knut Beitzel, M.A. (Sports Sciences)

is a specialist in orthopedics and traumatology as well as physical therapy and balneology and also works as an orthopedic/trauma surgeon at the Department for Orthopaedic Sportsmedicine at the University Hospital Rechts der Isar, Munich. Prior to his further training in emergency surgery at BG Unfallklinik (Emergency Clinic) Murnau, he spent one year as a research fellow in the field of sports orthopedics at the University of Connecticut (Farmington, USA). He previously worked as a resident at the clinic and polyclinic for orthopaedic sportsmedicine at Munich Technical University. Dr. Beitzel obtained both of his degrees in Medicine and Sports Science from the University of Bonn.

He is a member of the following professional associations: European Society of Sports Traumatology, Knee Surgery and Arthroscopy (ESSKA), Association for Arthroscopy and Joint Surgery (AGA), German Association for Shoulder and Elbow Surgery (DVSE), German Association for Sports Medicine and Preventive Medicine (DGSP), German-Aus-

trian-Swiss Association for Orthopedic-Traumatological Sports Medicine (GOTS). He is member of the Editorial Board for the Orthopaedic Journal of Sports Medicine and of the Reviewers Board for the American Journal of Sports Medicine. In 2013, he and Prof. A. B. Imhoff received the AGA medi Award for his paper entitled "Structural and Biomechanical Changes in Shoulders of Junior Javelin Throwers – A Multimodal Evaluation as a Proof of Concept for a Preventive Exercise Protocol".

Knut Stamer (Physiotherapist/Osteopathist)

is a physiotherapist and head of treatment at Medical Park Bad Wiessee St. Hubertus. He completed his training at the Private School for Physiotherapy in Loges, Oldenburg. This was followed by a probationary year at the central clinic in Augsburg. He began his work in a private physiotherapy practice and then at an outpatient rehabilitation center in Augsburg, where he assumed leadership of sports rehabilitation and care for the Augsburger Panthers (DEL ice hockey) as well as first FC Augsburg (soccer). Since 1998, he has been head of treatment at Medical Park Bad Wiessee St. Hubertus. In addition, he coached the long distance swimming A-Squad team of the German swimming association at the Beijing Olympic Games in 2008. Since 2009, he has advised the Chinese women's national athletics team in the disciplines of discus, shot put and hammer throwing. Knut Stamer specializes in the following fields: Manual therapy, sports physiotherapy, sports rehabilitation training, medical training therapy, osteopathy, neural structures, craniomandibular dysfunctions, applied kinesiology, kinesiotaping, Terapi Master training system (sling exercise system) and functional movement screen, and is part of Dr. Schleip's team of fasciae experts.

Elke Klein (Physiotherapist/Osteopathist)

is a physiotherapist and has been Department Head at Medical Park Bad Wiessee St. Hubertus since 2007. There, her patients include the athletes at cooperation partner Bavaria Olympic Training Center, the German ski association and FC Bayern Basketball. She previously worked as a physiotherapist on the team at the clinic and polyclinic for sports orthopedics at Munich Technical University. She completed her physiotherapy training at the college for Physiotherapy at Ludwig-Maximilians University in Munich.
Elke Klein also holds further training in the fields of sports physiotherapy, manual therapy, PNF, kinesiotaping, and the Terapi Master training system. This was followed by five years of study in osteopathy at the International Academy of Osteopathy (Germany).

Professor Augustus D. Mazzocca, MS, MD

is the Director of the UConn Musculoskeletal Institute and Chairman, Department of Orthopaedic Surgery at the University of Connecticut Health Center. He is the Director of the University of Connecticut Human Soft Tissue Research Laboratory, which consists of integrated translational labs incorporating cell and molecular biology, histology, biomechanics, and clinical outcomes research. He is also the Director of the University of Connecticut Bioskills Laboratory. Dr. Mazzocca holds a joint faculty appointment at the University of Hartford in the Department of Civil, Environmental, and Biomedical Engineering, College of Engineering Technology and Architecture.
International collaboration in both education and research is a top priority for Dr. Mazzocca bridging over six countries including Brazil, Japan, Austria, Germany, Italy, France and five of the seven continents. Dr. Mazzocca is internationally renowned for his work in the following areas: biceps tenodesis, distal biceps for the elbow, anatomic coracoclavicular reconstruction for the treatment of chronic acromioclavicular separation, and biologic augmentation of failed rotator cuff repair using concentrated bone marrow and platelet rich plasma. The extent of this research has led to 69 book chapters, 130 abstracts and posters and 133 peer reviewed journal articles.
Dr. Mazzocca also holds the following positions: he was the Program Director for the American Orthopaedic Society for Sports Medicine (AOSSM) for the 2015 International Meeting and a member at large for the AOSSM Nominating Committee from 2014-2015. In 2014, he served on the Upper Extremity Program Committee for Specialty Day.
Dr. Mazzocca has been a part of the American Shoulder and Elbow Society (ASES) Continuing Education Committee since 2009 and is a member of the Closed Meeting Committee for 2015 and 2016 and the ASES Continuing Education Committee from 2014-2015. He is also a member of the Arthroscopy Association of North America (AANA) Research

Committee since 2010. In 2003, Dr. Mazzocca was a founder of the New England Shoulder and Elbow Society (NESES) and continues to be part of its executive governing board since its inception in 2003. He remains an active member of AOSSM, ASES, AANA, and NESES as well as the following professional societies: American Academy of Orthopaedic Surgeons (AAOS), International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine (ISAKOS), The American Orthopaedic Association (AOA), Orthopaedic Research Society (ORS), European Society for Surgery of the Shoulder and Elbow (ESSE), American College of Sports Medicine Member (ACSM), and the Connecticut Academy of Science and Engineering (CASE).

Dr. Mazzocca has served on the editorial board for several orthopaedic publications including: Orthopedics Today Basic Science & Technology Section Editor 2014, Orthopedics Today Editorial Board from 2013 to present, Techniques in Shoulder and Elbow Surgery, Editorial Board from 2010 to present, Associate Editor – Journal of Bone and Joint Surgery-Shoulder and Elbow Newsletter from 2011 to present, Section Editor-Arthroscopy Section for the AAOS Orthopaedic Knowledge Update 4th Edition in 2011, Co-Editor of the AAOS Monograph Disorders of the Proximal Biceps Tendon in 2011. He also received several awards including: the Richard B Caspari Award- (Best International Upper Extremity Paper) ISAKOS in 2005, Albert Trillat Young Investigator Award and Scientific Award for Best Scientific Paper ISAKOS in 2009, and the American Academy of Orthopaedic Surgeons Distinguished Volunteer Service Award in 2014. He has been recognized as a America's Top Orthopedists Consumers' Research Council of America in 2007 and 2008, Outstanding Shoulder Surgeons and Specialists, Becker's Orthopedic & Spine Review in 2011, Best Doctor's in America® in 2014, Best Doctor *Hartford Magazine* from 2008 to 2015, a Castle Connolly Top Doctor from 2012 to 2015.

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Faculty Members

University Professor Andreas B. Imhoff M.D.
Chairman of the Department of Orthopaedic Sports-medicine
Hospital Rechts der Isar, Technical University of Munich
Ismaningerstreet 32
81675 Munich, Germany

Associate Professor Knut Beitzel, M.D. M.A.
(Sports Science)
Department of Orthopaedic Sportsmedicine
Hospital Rechts der Isar, Technical University of Munich
Ismaningerstreet 32
81675 Munich, Germany

Knut Stamer (Physiotherapist/Osteopathist)
Medical Park Bad Wiessee St. Hubertus GmbH & Co. KG
Sonnenfeldweg 29
83707 Bad Wiessee, Germany

Elke Klein (Physiotherapist)
Medical Park Bad Wiessee St. Hubertus GmbH & Co. KG
Sonnenfeldweg 29
83707 Bad Wiessee, Germany

Professor Gus Mazzocca M.S, M.D.
Chairman of the Department of Orthopaedic Surgery
University of Connecticut
Farmington, CT 06034, USA

Andreas Voss M.D.
Department of Orthopaedic Surgery
University of Connecticut
Farmington, CT 06034, USA
and
Department of Orthopaedic Sportsmedicine
Hospital Rechts der Isar, Technical University of Munich
Ismaningerstreet 32
81675 Munich, Germany

David Lam
Department of Orthopaedic Surgery
University of Connecticut
Farmington, CT 06034, USA

Introduction

Andreas B. Imhoff, Knut Beitzel, Knut Stamer, Elke Klein

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1.1 Idea behind the Book

The purpose of this book is to provide an individualized, concise, but nevertheless comprehensive overview of aftercare recommendations.

There has long been a consensus regarding the great importance of aftercare treatment following surgical interventions in sports orthopedics. While it is important to constantly improve surgical procedures and applied techniques, aftercare must also be consistently evaluated, adapted and improved in line with the latest developments. It is only possible to achieve the best possible treatment result through highly accurate diagnosis, perfect surgical care and optimum rehabilitation. This allows patients to regain the best possible level of activity in their everyday life or even their athletic performance.

In order for this to be possible, intensive cooperation between the patient, doctor, therapist, nursing staff and the further rehabilitation team involved in the treatment is required (◘ Fig. 1.1). The Department for Sports Orthopedics at TU Munich and the Medical Park Bad Wiessee St. Hubertus rehab clinic have been working successfully together as part of such an interdisciplinary team for a long time. The recommendations made here are the result of such cooperation, and form the basis of our treatment strategies and the associated many years of success.

This book aims to provide users with an interdisciplinary overview of the measures we feel are necessary over the course of rehabilitation. It attempts to bring together all directly involved professional groups into a holistic overview and to offer corresponding measures during the rehabilitation process. This means that there is a concept at all times throughout rehabilitation that facilitates the classification of the current treatment situation and the planning of the further course of rehabilitation. This does not aim to replace the individual diagnosis as a basis for treatment measures, but rather to serve as a suggestion and guideline for rehabilitation. The goal is to present the procedures applied in our daily practice.

1.2 Rehabilitation: Physiotherapy – medical training therapy – athletic ability

As part of the rehabilitation process, it is important to select a broad therapeutic approach that attempts to integrate a number of concepts and methods and implement them according to the specific diagnosis. The focus here must always be on the diagnosis and the stage of rehabilitation.

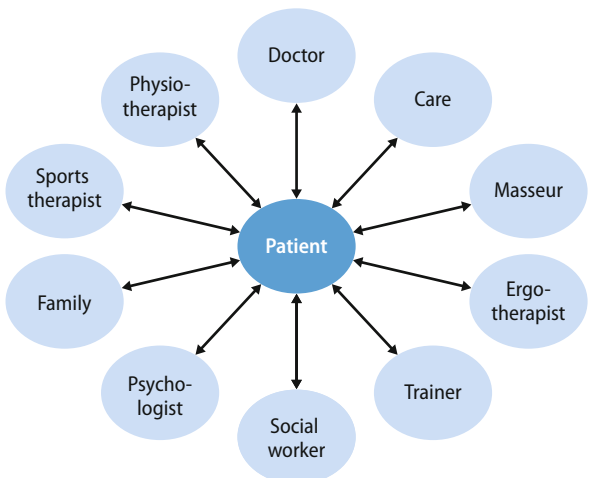
The treatment concept from the areas of physiotherapy and medical training therapy (MTT) form the focus of our rehabilitation concepts (◘ Fig. 1.2). They are supplemented by measures from the fields of ergotherapy, physical medicine (massage, hydrotherapy, electrotherapy etc.) and concomitant psychological measures. Often, it is not possible to put together a rehabilitation team with members from all fields due to financial and infrastructural reasons (inpatient rehabilitation → extended outpatient rehabilitation → remedies). In this case, the aftercare therapist (usually the physiotherapist) assumes the roles from the different treatment areas and allows as broad a spectrum of treatment content as possible to be covered as part of a combination treatment.

At the start of the rehabilitation process, measures from the areas of physical therapy and physiotherapy are the most prevalent. Further on, the proportion of traditional physiotherapeutic, ergotherapeutic and physical applications decreases, with MTT measures increasing and gaining significance accordingly. This results in a fluid transition throughout the entire course of rehabilitation, which then in the best cases leads to the resumption of sport-specific training, or to fully returning to work.

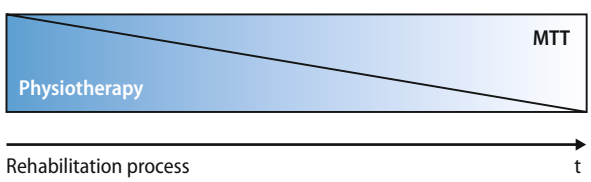
1.2.1 Rehabilitation process

Structure of the rehabilitation process

The structure of the rehabilitation process can be seen in ◘ Fig. 1.3.



◘ **Fig. 1.1** Composition of the rehabilitation team



◘ **Fig. 1.2** Course of treatment specialisms

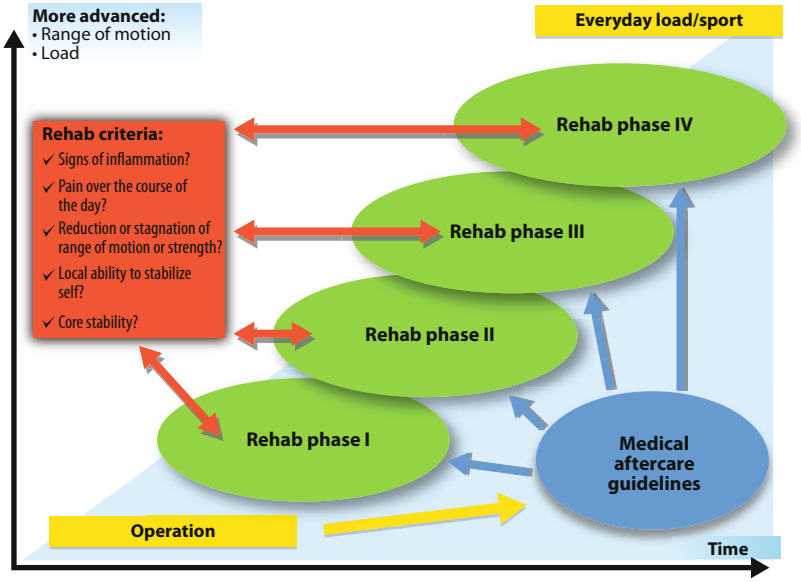


Fig. 1.3 Structure of the rehabilitation process

Principles of the rehabilitation process

- The time-related scheduling of the medical aftercare guidelines and therefore the progression of the phases of rehabilitation are determined from the factors of the **patient's character** (his/her secondary illnesses, sports experience etc.) and **operation** (technique, materials, complications etc.).
- The most important factors are continuous health assessment, comparison with the actual situation and adaptation of the treatment content by the therapists!
- Over the course of rehabilitation, when the physical load and range of motion are increased and under what circumstances is decided based o the doctor's aftercare guidelines.
- The rehabilitation criteria must be continuously reviewed – especially when it comes to increasing physical load!
- Using ICF criteria, specific goals are also set for each phase of rehabilitation, and their fulfilment is assessed.
- The treatment involved in the individual rehab phases must be applied in close alignment with the medical aftercare guidelines.

Features of the stages of rehabilitation

Fig. 1.4 provides an overview of the features of the individual stages of rehabilitation.

Phase	Features
Phase I	Post-operative acute phase
Phase II	Gradual increase in the range of motion and load (progression)
Phase III	
Phase IV	Approved range of movement and load

Fig. 1.4 Features of the stages of rehabilitation

1.2.2 Physiotherapy

The **first principle** in the management of treatment measures is the observance of individual load limits specified by the doctor. These are primarily based on the phases of wound and tissue healing (Table 1.1) as well as the biomechanical properties of surgical techniques.

The **second principle** is continuous monitoring for signs of inflammation (dolor, tumor, rubor, calor, and functio laesa), which indicate that the patient is undergoing excessive load. These also include general signs of exhaustion and excessive load (tiredness, fatigue, loss of motivation etc.) that are a result of excessive training or overly intensive treatment. At the same time, the onset of the above symptoms means that the development of an infection must be considered and ruled out where necessary.

Due to the complex reactions and compensation strategies the body has to injuries, degenerative damage, and following surgery, particular attention should be paid to secondary dysfunctions in terms of the chain of cause and effect throughout rehabilitation. We see this as the **third principle**, as here each primary physical dysfunction has an effect on the other parts of the body linked via a chain

Table 1.1 Treatment measures depending on the phase of wound and tissue healing

Wound and tissue healing phases	Focus points of treatment
Acute phase	Rest, elevation, vegetative therapy, nutrition
Inflammatory phase	Vegetative therapy, local blood circulation stimulation, pain ↓, matrix load, manual therapy level 1, proprioception, nutrition
Proliferation phase	O_2↑, mobilization with increasing load, manual therapy stages II-II, coordination, proprioception, training therapy
Remodeling phase	Functional movement, mobilization, specific loads, forced training therapy, sport-specific training

of effects. It is important for these to be observed regularly and included in treatment where appropriate. Some examples of chains of cause and effect can be found in ▶ Section 7.3.1 and in ▶ Section 15.3.1.

As a **fourth principle**, another important factor in all of our aftercare stages is posture. Optimum core stability forms the basis for the best possible force distribution along the kinetic chain, which makes it possible for the limbs to be used correctly and powerfully. Strength in the extremities is generated in the core. Posture training and improvement as well as improving coordination and strength should therefore be integrated into each stage of rehabilitation.

Continuous communication with the patients and within the rehabilitation team regarding the treatment methods, course of therapy, incidence of illness and the associated limitations in activity is the **fifth principle**. This includes continuously explaining and educating the patient about his/her condition and the treatment methods used (education).

The Five Principles of Physiotherapy
- Physician prescriptions and personal load limits
- Signs of inflammation and excessive load
- Chain of cause and effect
- Posture
- Communication and education

In addition to the underlying principles, particular attention should be paid to the following treatment principles, especially during the application of individual physiotherapeutic measures.

General Principles of Physiotherapeutic Treatment
- Subjective patient sensations
- Patient compliance
- Pain-free position
- Do not exercise beyond the individual pain threshold (maximum level 3-4 of VAS)
- For tissue techniques, give the tissue time for the mechanic impulse to take effect so that a tissue reaction can take place
- Inhibition/mobilization/stabilization
- Vasoregulation and lymphatic/venous drainage
- Treatment takes place distally to proximally in the event of acute neural pain symptoms

1.2.3 Medical training therapy (MTT)

In addition to the points already specified for physiotherapy, MTT is based upon the principles of general training methods. The decisive stimuli for the prescription of training load are controlled via the load components:

Load components of medical training therapy
- Intensity
- Density
- Duration
- Scope
- Frequency

In addition to load components, in MTT, the quality of movement is a main criterion when it comes to increasing loads. The load should only be increased once the optimum quality of the movement performed has been reached (flow, rhythm, and extent of movement).

In addition, the load extent and duration are increased first of all, and then the load intensity and density are increased. Major content of medical training therapy lies in the transfer of coordinative skills. The patient should relearn or improve his/her pre-traumatic economic and coordinated movements. Any pre-existing deficits can be corrected and their recurrence can be avoided.

The content of the individual therapy should build upon each other and facilitate progression, which leads to effective load stimuli. After an appropriate break, these lead to the eventual supercompensatory adaptation of the organism. The following principles arise in MTT as pre-requisites for training therapy without damaging stimuli:

Principles of medical training therapy
- No training if signs of inflammation are present
- Training only within the pain-free range
- Training within the range of free mobility
- Training within the crepitation-free range
- Training with pre-stretching only from phase III
- Avoiding shear loads
- Adjusted weight load (Cave: Overload)
- No rapid or explosive movements (up to and including phase III)
- The training must remain stable for at least three days of exercise. Only thereafter can the load be increased

Taking these principles into account, an increase in load is strived for in accordance with the following training principles:

General training principles
- Easy to difficult
- Simple to complex
- Limited to full range of motion (ROM)
- Large to small support surfaces
- Stable to unstable surface
- Short to long lever
- Slow to fast
- One-dimensional to multi-dimensional
- General to sport-specific

In addition to the passive and active application and types of training, machine-supported training enables the training content and stimuli to be expanded. The patients can perform their exercises on specific machines independently following introduction and under constant supervision. In addition, the high overall number of reps offers the option to automate the flows of movement. Nevertheless the regular supervision and further development of exercises on the basis of training theory laws are indispensable. The focus of training therapy should always lie in functional, three-dimensional forms of exercise, as these represent a higher challenge for the patient in terms of coordination. Furthermore, closed-chain training with core involvement is preferred and should be used as much as possible. Open chain training supplements the functional approach in everyday and sport-specific exercises.

The following underlying aspects must be considered during machine-supported training:

Underlying aspects of machine-supported training
- Therapeutic and biomechanical aspects
- Position of the resistance
- Correct axial alignment of the patient
- Prescribing load components
- Reduction of damaging accompanying movements
- Choice of movement path
- Choice of starting position
- Functional direction of the training content in accordance with the phases of rehabilitation

The principles set out here only represent the most important basis of the forms of therapy applied in rehabilitation. They are expanded and thereby are only rounded off by the specific perspectives of the individual schools and theories of physiotherapy and sports therapy. It is only possible to provide a brief overview of the principles in the context of this book, however.

1.2.4 Athletic ability

The importance of sporting activities in health and general well-being is now undisputed. In addition, many sports orthopedics patients want to resume the sporting activities they previously participated in following the surgical treatment of an injury or a degenerative illness, and enjoy physical activities. Over the course of rehabilitation, the question as to whether or when it will be possible to resume sporting activities often arises.

Even when sports activities are recommended, for example especially in the case of endoprosthetic care, it is only possible to give an answer after having taken into account the patient's personal requirements, the underlying surgical procedure, and the rehabilitation. In this respect, intensive communication within the rehabilitation team has proven to be extremely helpful: in particular, the type of underlying injury/illness, the operation performed, any complications that may have arisen and any additional pre-existing illnesses are key here. Of similarly great significance is whether the patient wishes to commence a certain type of sport that s/he used to practice intensively or whether s/he wishes to take it up for the first time (life-time athlete/returnee/beginner). This has a drastic influence on the suitability of a particular sport for the individual patient.

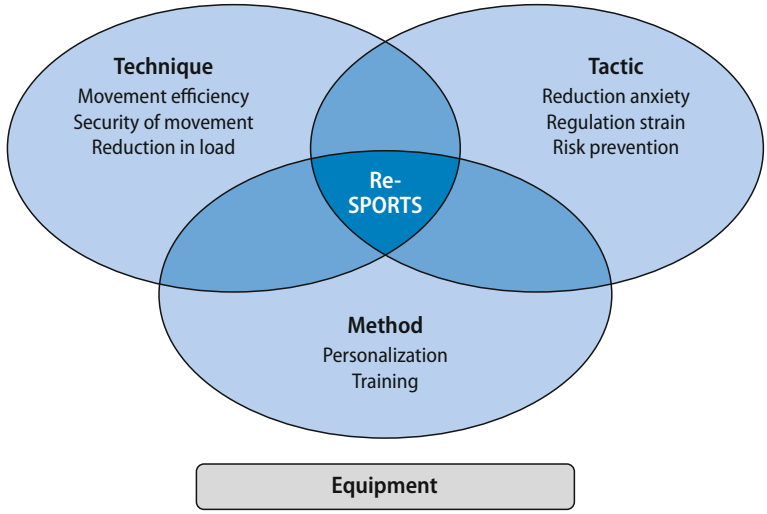


Fig. 1.5 Features of the Medical Park ReSPORTS® concept

It should always be borne in mind that a sport can also be practiced in a modified way (more relaxed technique when skiing, adapted swing when playing golf, no participation in competitions, etc.).

In our daily practice, the following additional criteria with regard to the intended type of sport have proven to be reliable:

Criteria for resuming sports activities

- Absence of signs of inflammation and excessive load
- Expected stability of the implants, fixations or reconstructions to be applied
- Sufficient pain-free passive and active mobility
- Sufficient muscular and ligament stability (absence of evasive movements)
- Sufficient conditional characteristics (especially coordination, strength, endurance)
- General ability to resume sporting activities with regard to secondary illnesses
- Adapted patient motivation and understanding regarding any potential risks and restrictions in the intended type of sport (e.g. in the case of endoprostheses)

The patient often sees the time until s/he is ready to resume their sport physical activity as the most crucial factor, but this should be of secondary importance. The fulfilment of the specified criteria is the most important factor, with this resulting in the optimum time to resume sporting activities. This keeps the illness-related risk of an injury or harm due to load as low as possible.

In the perfect case, the rehabilitation team will support the patient until s/he is ready to commence sport-specific training and to rejoin the training process. Even among leisure and amateur sports players, success has been demonstrated in the application of the Medical Park ReSPORTS® concept (Fig. 1.5). In this concept, the patients are integrated into specific sports (skiing, golf, etc.) by specially trained therapists, trainers and doctors. Through intensive information measures, the demonstration of specific adapted techniques, the preparation of optimum environmental conditions and mental support, it is possible even for less sporty patients to learn a new sport or resume an old one.

The following graded recommendations apply to the aftercare guidelines presented here accordingly. Once full load-bearing ability has been achieved, the desired type of sport can be resumed for running, swimming and cycling. This includes training for sport-specific load types. In this respect, targeted types of movement for the intended sport can be practiced or relearned while protecting the parts of the body that underwent surgery or with modified techniques. The load can only be increased later once the patient has regained full training ability.

The terms contact and high-risk sports refer to sports with an increased risk of injury. These include sports with opponent contact (handball, soccer, etc.), but also those such as skiing. These should be taken up later on in the course of rehabilitation, and require intensive preliminary treatment through adjusted sport-specific training.

1.3 ICF Model: Objective and planning of the course of rehabilitation

The goal of surgical care and rehabilitation in sports orthopedics is to achieve the best possible restoration of the pa-

tient's everyday and sporting ability. The primary goal of a rehabilitation program therefore lies in creating an environment in which various wound healing processes can run as best as possible, and where all negative and obstructive factors can be eliminated.

From our perspective, the definition of goals and planning of the rehabilitation process begins upon the primary diagnosis and treatment decision. At this point, the treatment and rehabilitation goals are determined in close cooperation between the team members and the patient (as a valuable team member). The patient's hopes and requirements should be adapted to the expected treatment or rehabilitation prognosis through information and explanations.

The International Classification of Functionalities (ICF) was introduced by the World Health Organization in 2001 as a basis for goals in rehabilitation. They enable the rehabilitation process to be considered as a whole, which covers the areas of bodily functions/structure, activity and participation (Fig. 1.6). In this case, the rehabilitation targets should not only focus on the injured or operated part of the body, but rather the patient as a whole, and thereby optimize treatment.

Realistic and clearly defined rehabilitation goals are defined on the basis of the ICF and in conjunction with the underlying illness/injury, patient expectations, the achievable result of surgery and the available resources. These are divided into long-term and medium-term goals according to the phase-based course of rehabilitation. In addition, specific short-term goals can be defined for individual treatment measures.

The medical aftercare guidelines specified have a decisive influence on planning and the setting of objectives. They specify time frames in which physiological healing processes are facilitated and excessive loads must be avoided. The course of aftercare is not only based on these time-related requirements, but also on the individual rehabilitation potential and the abilities and skills of the patients.

For this reason, we prefer a combined time-based and symptom-based approach. Depending on the defined goals and the actual condition, the course of rehabilitation should be constantly evaluated on the basis of symptoms and adjusted where appropriate. This makes it possible for the rehabilitation process to be personalized even further. This approach requires the intensive exchange of information between the team members involved and the patient being continuously informed.

As the aftercare guidelines are defined according to the surgical procedure and its specific characteristics by the treating physician, any adjustment can only be made in consultation with this doctor.

Corresponding objectives and suggested criteria that we feel are necessary in the respective phases can be seen in the rehabilitation concepts and aftercare guidelines displayed. They should be considered as a suggestion and adapted according to individual requirements.

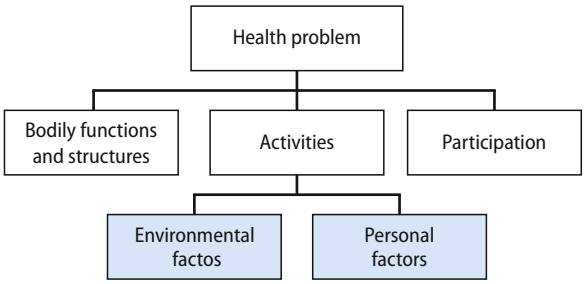


Fig. 1.6 Structure of the International Classification of Functionalities (ICF)

1.4 Principles of Diagnostics

The principles of diagnostics can be presented in the form of an overview below. Furthermore, reference is made to current reference books (▶ Section 1.5) as well as relevant training courses from the professional associations.

The examination should always take place in an atmosphere in which the patient feels comfortable. Privacy should always be guaranteed. The course and purpose of the examination should be explained to the patient. The patient should adopt a position as relaxed and pain-free a as possible during the examination.

The physiotherapeutic functional examination complements the medical diagnosis. Functional diagnostics can be divided into subjective and objective examinations. In this case, not only the current problem but also contributing or maintaining processes that could exacerbate or affect the patient's discomfort should be ascertained. Mental and social aspects should also be recorded (ICF used as a basis). A working hypothesis is then developed and goals are agreed upon with the patient.

Diagnostics should always take place in a standardized way that is described briefly below. This routine is the only way to ensure the comparability and reliability of results.

1. Medical history

Current and general state of health; initial suspected diagnosis or identification of structures that could cause discomfort.

a. Current medical history
b. General medical history
   - Medications taken: which and what for?
   - Discomfort/illnesses:
     Exercise equipment?
     Heart/cardiovascular?
     Lungs/breathing?

Digestive system?
Urogenital?
Endocrine?
- Trauma: when and what?
- Operation: when and what? Ongoing discomfort?
- Profession and hobby
- Height and weight
- Stimulants and eating habits

c. Specific medical history
d. Pain
- What, when, how, by what means, with what?
- Pain location
- Periods of pain
- Pain characteristics
- Triggering pain
- Pain improvement
- Concomitant circumstances

Info regarding the patient potentially being referred back to the doctor to discuss symptoms further: Pain progression, lasting pain, pain at night, immediate pain when bearing weight

2. Inspection

a. Everyday movements (putting on and taking off clothes, lifting and carrying, walking)
b. Changes in the skin
c. Changes in bodily relief (scars, fascial retractions, muscular atrophy, edema, swelling, connective tissue massage zones)
d. Change in posture (post-urology)
- Rotation type: Deviations on horizontal level
  Reference points: Calacanei, SIPS, scapula
- Lateral bending type: Deviations on frontal level
  Reference points: imaginary perpendicular sagittal structure – medial scapula – spinous process – gluteal fold
- Extension/flexion type: Deviations on sagittal level
  Reference points: Perpendicular external ear canal – shoulder – pelvic – knee – external ankle
- Spine: Spinal shape on sagittal and frontal level, thorax shape, head and neck position, swelling between the erector spinae muscle and spinosus, skin changes
- Shoulder: Shoulder elevation, winged scapula, rotation position of the scapula, scoliosis of the thoracic spine, flat back or kyphosis of the thoracic spine, protraction of the shoulder girdle, anterior position of the humeral head
- Hip: Pelvic position, leg-pelvic angle, muscle relief
- Knee: Patella position, swelling, effusion, atrophy of the muscles, tibial torsion, antetorsion angle, leg axis
- Foot: Arch shape, heel bone axis, forefoot and toe position, position of external and internal ankle, circulatory disorders, swelling, calluses, toe nails

3. Palpation

a. Irritation in the area of the dermatome
b. Changes in connective tissue: CTM zones, neuro-lymphatic reflex points, neurovascular points, Head zones
c. Changes in muscle tone: Trigger points, tender points, changes in the tone of the muscle as a whole

Swelling, tension or pain are considered upon palpation. In the case of pain, the radiation (dermatome-related or not), character, severity and duration of the pain should be considered. It should also be determined whether the pain lingers.

All conspicuous structures upon palpation should be examined precisely and treated accordingly, as these could be a potential cause of the discomfort or could be exacerbating it.

4. Functional examination

Active and passive examination of structures such as bones, joints, muscles, ligaments, capsules.

a. Axial system
- Head joints
- Vertebral joints
- Costovertebral joints
- Sacrum and sacrococcygeal joint

Examination of the spine:
- Examination of the groin-pelvic-hip region while standing:
  - Flexion while standing – extension areas?
  - Extension while standing – flexion areas?
  - Lateral bending
  - Forward flexion phenomenon: further inspection of sacroiliac joint during
    ilium rotations, inflate and outflare, sacrum lesions, up slip and down slip
    Sitting
    in prone position, supine position, lateral position
  - Prone position: Springing test or p.a. boost
- Examination of the thoracic spine and ribs
  - Sitting
  - in prone position, supine position, lateral position
- Examination of the cervical spine
  - Sitting
  - In supine/prone position

For the connections to vegetative nervous systems as well as the organ system, see ▶ Section 19.2.1.

Abnormal findings regarding loss of movement, swelling, misalignment are divided into group lesions (at least three vertebral segments in a certain direction) or individual lesions (one vertebral segment).

In the case of group lesions, the relevant organs, vessels, muscles, etc. are treated first. Where still necessary, group lesions can be corrected subsequently. Techniques to treat organ fascia are only displayed if there is a restriction in movement.

In the case of individual lesions, the blockage must first be cleared.

Neurotension test: Slump, SLR and PNB, should there be indications from the medical history (points along the track).

b. Extremities

The movement test consists of the following:

- Active and passive movements (including end point), pain when stretching
- Distraction and compression of the joint
- Muscle function testing
- Measuring joint mobility in accordance with the neutral zero method

5. Provocation test

Pain as an indicator of a problem; provocation test as exclusion test for potential contraindications or to confirm a previous suspected diagnosis.

The structures are provoked via:

- Contraction (active)
- Compression (passive)
- Distraction (passive)
- Stretching (active or passive)
- Convergence (active or passive)

6. Neurological and angiological examinations

- Reflexes, reference muscles
- Sensitivity testing
- Motor skills
- Coordination and vegetative deregulation
- Walking distance
- Risk factors: Age, smoking, obesity, metabolic disorder, physical inactivity, vasculopathy, family history
- Skin temperature
- Pulse status

7. Functional tests

Lumbar spine:

- Movement control test:
  - "waiter's bow"
  - "pelvic tilt"
  - "rocking forwards"
  - "rocking backwards"
  - Knee flexion in prone position
  - Knee extension while sitting

Scapula:

- Activation pattern:
  - Wiping exercise for trapezius muscle/levator scapulae muscle
  - Biceps curl for pectoralis major muscle
- Assessing the upward/downward movement of the scapula in the case of elevation on scapular level
- Static stability:
  Plank against the wall or in quadrupedal position to assess the strength development of the serratus anterior muscle

Lower extremity/entire body:

- Gait analysis
  - Gait
  - Up and downstairs
  - Test for medial collapse
  - Walking speed test

8. Special tests

- Controlling core stability when standing on one leg
- Impingement test in accordance with Neer and Hawkins
- Instability tests:
  - Front and rear apprehension test
  - Load and shift test
  - Relocation test
- Inferior instability testing: Sulcus sign
- SLAP stability test: Supine flexion resistance test
- Functional movement screening

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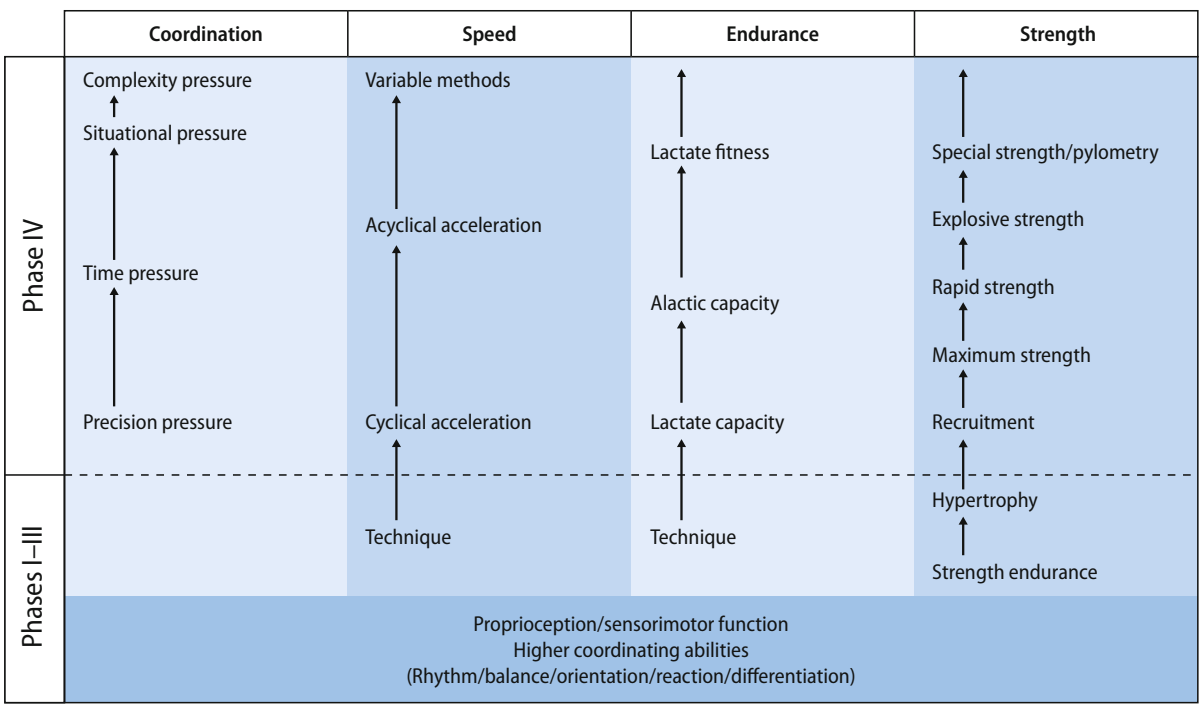
Upper Extremity

Strategy for the rehabilitation of the upper extremities (stages I-IV)

- Safeguarding the result of the surgery:
  - Patient education,
  - Anatomical, biomechanical, pathophysiological and neurophysiological knowledge (wound healing phases, tissue regeneration time),
  - Knowledge of the surgical procedure,
  - Patient/athlete compliance.
- Improving the mobility of the shoulder and scapulothoracic joint as well as the surrounding structures.
- Inhibition of incorrect muscle involvement.
- Scapular setting ("static control" and "dynamic control").
- Humeral head centering.
- Sensorimotor function/coordination/hand-eye coordination.
- Core stability.
- Coordinating the entire shoulder girdle musculature with core involvement along the entire kinetic chain.
- Exercise: Strength, endurance and speed of the entire shoulder girdle/core (see rehab phase IV).
- Throwing, kicking.
- General and sport-specific training.

Weighting of treatments over the different phases			
	Phase II	Phase III	Phase IV
Physiotherapy	35%	15%	5%
Sensorimotor function	25%	30%	25%
Strength training	10%	25%	35%
Sport-specific training	10%	10%	25%
Exercising local stabilizers	20%	20%	10%

Training content of sports therapy for the upper extremities



- The contents are divided into four conditional areas of coordination/speed/endurance/strength.
- Each area begins with proprioception or sensorimotor function and ends once all stages have been passed through. No points are to be skipped, where possible.
- In addition, the areas are connected in parallel, i.e., the content for strength also applies to the content on the same level for endurance, coordination and speed.

Shoulder: Surgical procedure/aftercare

Andreas B. Imhoff, Knut Beitzel, Knut Stamer, Elke Klein

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DOI 10.1007/978-3-662-49149-2_2,

2.1 Muscle/Tendon Repair

2.1.1 Reconstruction of the rotator cuff

In principle, the reconstruction of tendon defects in different areas follows the same surgical technique. Modifications may be made depending on the size and location of the defect. A distinction is made between **partial** and **complete tendon rupture**, where complete rupture refers to the tendon having torn completely from the articular side to the bursal side. (**Cave:** no information regarding the size of the rupture has been defined here!) The location of the lesion can be differentiated into: **anterior, anterosuperior, superior, and posterosuperior**.

Indication

- Acute traumatic lesion of the rotator cuff tendons (RC) [supraspinatus muscle (SSP), infraspinatus muscle (ISP), teres minor muscle (TM), subscapularis muscle (SSC)].
- Degenerative lesions in the tendons of the rotator cuff.
- Traumatic shoulder dislocation rupture of the rotator cuff

Surgical method

- General anesthesia and scalene catheter for regional analgesia (continues for approx. three days postoperatively).
- Arthroscopy via standard dorsal access to assess the existing articular pathology. Intraarticular care of SSC lesions is accomplished by releasing the tendons and refixation using suture anchors depending on the extent of the lesions. In the event of additional lesions on the long biceps tendon, an arthroscopic tenodesis of the tendon with refixation using suture anchors or tenodesis screws is necessary.
- Change to the subacromial space, bursectomy, denervation, electrothermic hemostasis and subacromial decompression with the shaver (acromion type III).
- Representation of tendon lesions on the bursal side, mobilization of the tendons, the lysis of adhesions and the debridement of the insertion site at the greater and lesser tubercles.
  (In the mini-open technique, this step takes place via an approx. 4cm long skin incision with split in the deltoid muscle.)
- Retraction and refixation of the tendons using suture anchors.
- Potentially additional securing of the reconstruction through a second lateral series of suture anchors using a double row technique to increase the size of the insertion area (◘ Fig. 2.1).
- With additional biceps tendon pathology: fixation of the previously proximally separated tendon with suture anchor (LBS tenodesis) or suture of the tendons (soft tissue tenodesis) in the bicipital groove. Alternatively, the tendon can also be detached at the point of origin (LBT tenotomy).

Aftercare

An overview of aftercare can be found in ◘ Table 2.1, ◘ Table 2.2 and ◘ Table 2.3.

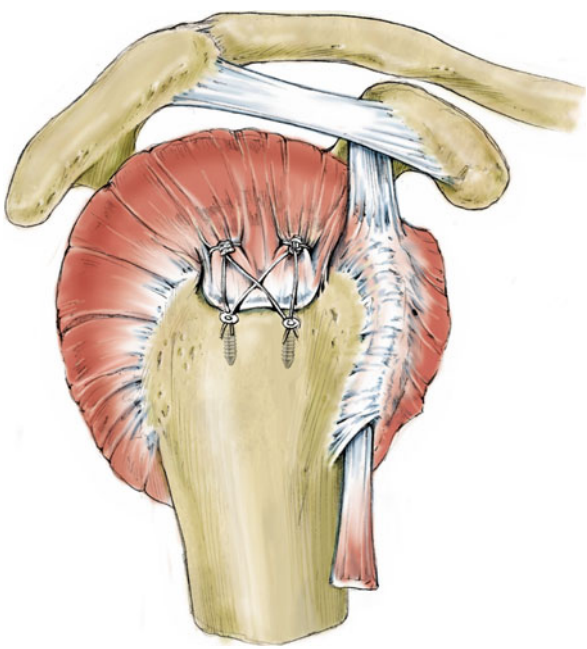
2.1.2 Latissimus dorsi transfer

Indication

- Non-reconstructable superior and posterosuperior defects in the rotator cuff of the active patient with market functional and movement restrictions (no signs of arthrosis and intact subscapularis muscle).

Surgical method

- Anterolateral skin incision with split of the deltoid muscle between the anterior and medial pars.
- Debridement of the supraspinatus and infraspinatus muscles and tenodesis of the LBT.
- Second incision dorsally, z-shaped on the front edge of the latissimus dorsi muscle in the direction of the rear axillary fold.
- Preparation and mobilization of the muscle, then separation at the insertion site.



◘ **Fig. 2.1** Reconstruction of the supraspinatus and infraspinatus muscles using the suture bridge technique

Table 2:1 Reconstruction of the anterior RM lesion (SSC). Shoulder abduction orthosis in 15° abduction (e.g., medi® SAS 15) for 4-6 weeks

Phase	Range of motion and permitted load	
I	1st to 3rd weeks post-op:	Passive abduction/adduction: 90°/15°/0° Passive flexion/extension: 90°/15°/0° Passive IR/ER: free/0°/0° Active assisted ER: up to 0°
II	4th to 6th weeks post-op:	Active assisted abduction/adduction: 90°/15°/0° (passive: free) Active assisted flexion/extension: 90°/15°/0° (passive: free) Passive IR/ER: free/0°/0° Active assisted ER: up to 0°
III	from 7th week post-op:	Free active assisted mobility
	from 9th week post-op:	Free active mobility
	from approx. 12th week post-op:	Jogging
IV	approx. 4 months post-op:	Cycling, swimming (no raising arm above the head, e.g., no crawl or butterfly stroke)
	approx. 6 months post-op:	Sport-specific training subject to consultation with a physician (e.g. starting golf/tennis/skiing)
	approx. 9 months post-op:	Contact and high-risk sports

Table 2.2 Reconstruction of the anterosuperior RM lesion (SSC and SSP). Shoulder abduction orthosis in 30° abduction (e.g. medi® SAK) for 4–6 weeks

Phase	Range of motion and permitted load	
I	1st to 3rd weeks post-op:	Passive abduction/adduction: 90°/30°/0° Passive flexion/extension: 90°/30°/0° Passive IR/ER: free/0°/0° Active assisted ER: up to 0°
II	4th to 6th weeks post-op:	Passive abduction/adduction: free/30°/0° Active assisted abduction/adduction: 90°/30°/0° Passive flexion/extension: free/30°/0° Active assisted flexion/extension: 90°/30°/0° Passive IR/ER: free/0°/0° Active assisted ER: up to 0°
III	from 7th week post-op:	Free active assisted mobility
	from 9th week post-op:	Free active mobility
	from approx. 12th week post-op:	Jogging
IV	IV approx. 4 months post-op:	Cycling, swimming (no raising arm above the head, e.g. no crawl or butterfly stroke)
	approx. 6 months post-op:	Sport-specific training subject to consultation with a physician (e.g. golf)
	approx. 9 months post-op:	Contact and high-risk sports (e.g. tennis)

- Leading the muscle through the interval between the posterior deltoid muscle and long tendon of the triceps brachii muscle and fixation in abduction and external rotation position in the region of the lesion on the greater tubercle using an suture anchor system (Fig. 2.2).

Aftercare

Table 2.4 provides an overview of aftercare.

Table 2.3 Reconstruction of the superior and posterosuperior RM lesion (SSP, SSP and ISP). Shoulder abduction orthosis in 30° abduction (e.g. medi® SAK) for 4–6 weeks

Phase	Range of motion and permitted load	
I	1st to 3rd weeks post-op:	Passive abduction/adduction: 90°/30°/0° Passive flexion/extension: 90°/30°/0° Passive IR/ER in 30° abduction position: free
II	4th to 6th weeks post-op:	Passive abduction/adduction: free/30°/0° Active assisted abduction/adduction: 90°/30°/0° Passive flexion/extension: free/30°/0° Active assisted flexion: up to 90° Active assisted IR/ER: in abduction position: free
III	from 7th week post-op:	Free active assisted mobility
	from 9th week post-op:	Free active mobility
	from approx. 12th week post-op:	Jogging
IV	approx. 4 months post-op:	Cycling, swimming (no raising arm above the head, e.g. no crawl or butterfly stroke)
	approx. 6 months post-op:	Sport-specific training (begin tennis and golf, for example, subject to consultation with a physician)
	approx. 9 months post-op:	Contact and high-risk sports

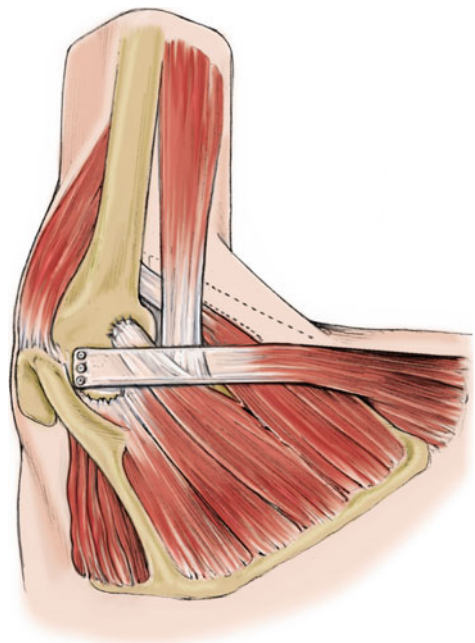


Fig. 2.2 Latissimus dorsi transfer with non-repairable rotator cuff lesions

2.1.3 Pectoralis major transfer

Indication

- Non-reconstructable anterior and anterosuperior defects of the rotator cuff.

Surgical method

- Deltoideopectoral access and preparation of the insertion site of the subscapularis muscle and the entire insertion site of the pectoralis major muscle at the humerus.
- Tenodesis of the LBT.
- Detaching the superior half of the pectoralis major muscle in the insertion area and separation of the muscle fibers of the clavicle and sternacostal head of a length of over approx. 10cm.
- Leading the muscle stump behind the short biceps tendon and the pectoralis minor muscle while preserving the musculocutaneous nerve.
- Fixation of the muscle stump to the minus tubercle through suture systems (in the event of an anterior-superior defect, also fixation in the area of the anterior major tubercle).
- Potentially, additional closure of a defect in the supraspinatus muscle (see above).

Aftercare

Table 2.5 provides an overview of aftercare.

Table 2.4 Latissimus dorsi transfer. Should abduction plaster or abduction splint in 45° abduction, 45° flexion and 45° internal rotation for six weeks

Phase	Range of motion and permitted load	
I	1st to 3rd weeks post-op:	Lymph drainage only Purely passive physiotherapy from the plaster (greatly limited, passive IR up to 0° in abduction position, passive ER free, passive abduction/adduction: 90°/45°/0° on glenoid level)
II	from 4th week post-op:	Taking the pain threshold into consideration: active assisted abduction/adduction: 90°/45°/0° Passive IR: up to 0° in abduction position ER: passive free (Cave: also exercising of the elbow joint on all levels)
	following end of 6th week post-op:	Inspecting plaster cast, adjusting a shoulder abduction cushion and intensified physiotherapy
III	from 6th week post-op:	Active assisted abduction/adduction: 90°/0°/0°, active assisted IR/ER: 30°/0/free (increase slowly)
	from 8th week post-op:	Free mobility (under medical supervision)
	from 12th week post-op:	Jogging
IV	approx. 4 months post-op:	Cycling, swimming (no raising arm above the head, e.g. no crawl or butterfly stroke)
	approx. 6 months post-op:	Sport-specific training
	approx. 9 months post-op:	Contact and high-risk sports

Table 2.5 Pectoralis major transfer. Shoulder joint bandage (e.g. medi® SLING) for six weeks

Phase	Range of motion and permitted load	
I	1st to 6th weeks post-op:	Passive abduction/adduction: 90°/0°/0° Passive flexion/extension: 90°/0°/0° Passive IR/ER: free/0°/0°
II	7th to 8th weeks post-op:	Passive abduction/adduction: free/0°/0° Active assisted abduction/adduction: 90°/0°/0° Passive flexion/extension: free/0°/0° Active assisted flexion/extension: 90°/0°/0° Active assisted IR/ER: free/0°/0°
III	from 9th week post-op:	Free active assisted mobility
	from 12th week post-op:	Free active mobility
	from approx. 12th week post-op:	Jogging
IV	approx. 4 months post-op:	Cycling, swimming (no raising arm above the head, e.g. no crawl or butterfly stroke)
	approx. 6 months post-op:	Sport-specific training
	approx. 9 months post-op:	Contact and high-risk sports

2.1.4 Arthroscopic AC joint resection (ARAC)

Indication

- AC joint arthroses (also as combined surgery in the case of rotator cuff reconstruction).
- Post-traumatic arthroses following AC joint dislocations.

Surgical method

- Glenohumeral arthroscopy of the shoulder joint via standard dorsal access to assess any additional pathologies.
- Switch to subacromial, denervation, bursectomy and presentation of the under-surface of the AC joint.

Table 2.6 AC joint resection (ARAC). Shoulder joint bandage (e.g. medi® SLING) for 24 hours, then for three weeks primarily at night and during longer walking load or activities

Phase	Range of motion and permitted load	
	6 weeks post-op:	No horizontal adduction
I	1st to 2nd weeks post-op:	Active assisted flexion/extension: 60°/0°/0° Active assisted abduction/adduction: 60°/0°/0° Free rotations
II	3rd to 6th weeks post-op:	Active flexion/extension: 90°/0°/0° and active abduction/adduction: 90°/0°/0° within the pain-free range (short lever arm, lift-free, near the joint)
III	from approx. 6th week post-op:	Jogging
IV	approx. 12 weeks post-op:	Cycling, swimming (no raising arm above the head, e.g. no crawl or butterfly stroke)
	approx. 4 months post-op:	Sport-specific training
	approx. 6 months post-op:	Contact and high-risk sports

- Triangular resection of the AC joint through hemostasis and denervation (e.g. OPES®) and shaver over additional anterior access before the AC joint.

(Saving the cranial and dorsal part of the clavico-acromial ligamentous apparatus)

Aftercare

Table 2.6 provides an overview of aftercare.

2.2 Stabilization

Depending on the underlying pathology, anterior, posterior or combined arthroscopic stabilizations of the shoulder joint may be performed.

2.2.1 Arthroscopic anteroinferior shoulder stabilization

Indication

- Status post traumatic shoulder dislocation in a young patient.
- Chronic post-traumatic instability.
- Recurring subluxations and dislocations.

Surgical method

- Diagnostic round via the dorsal standard portal with assessment of the existing pathology.
- Inserting an anterosuperior portal to prepare the anterior glenoid edge.
- Mobilization of the capsule-labrum complex with a Bankart knife.
- Debridement with a Bankart rasp (stimulating circulation) and placement of bony trough on the anterior glenoid edge (depending on the extent of the defect).
- Inserting the deep anteroinferior portal (5:30 access).
- Threaded hole and placing the first bioresorbable suture anchor into the inferior bone groove.
- Suturing the capsule-labrum complex using a curved hypodermic needle.
- Tying through slipknots and knot pushes into the desired rotation position of the arm (should there be a bony Bankart lesion, this can also be fixed). The same approach in the direction of the superior for further suture anchors. (Fig. 2.3)
- **Sole capsular shift (capsular plication):** A W-shaped interweaving of the anterior capsular labrum complex and tying using PDS threads is performed without anchor fixation.

Aftercare

An overview of aftercare can be found in Table 2.7 and Table 2.8.

2.2.2 Arthroscopic posterior shoulder stabilization

Indication

- Status post traumatic dorsal shoulder dislocation.
- Chronic post-traumatic dorsal instability.
- Recurring dorsal subluxations and dislocations.

Surgical method

- Diagnostic tour via the dorsal standard portal.
- Preparation of the rear glenoid edge.

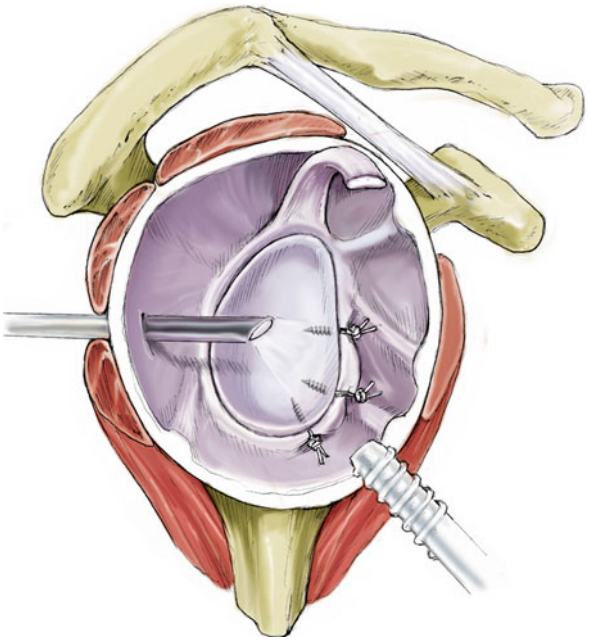


Fig. 2.3 Arthroscopic anteroinferior stabilization with three bioresorbable suture anchors via the deep antero-inferior portal

- Mobilization of the capsule-labrum complex with a Bankart knife.
- Debridement with a Bankart rasp (stimulating circulation) and placement of bony trough (in the case of labrum lesions).
- Threaded hole and placement of the first bioresorbable suture anchor into the inferior bone groove.
- Suturing the capsule-labrum complex using a curved hypodermic needle.
- Tying with slipknots and knot pusher into the desired rotation position of the arm (should there be a bony Bankart lesion, this can also be fixed). The same approach in the direction of the superior for further suture anchors.
- **Sole capsular shift (capsular plication):** A W-shaped interweaving of the posterior capsular labrum complex and tying using PDS threads is performed.

Aftercare

An overview of aftercare can be found in Table 2.9 and Table 2.10.

2.2.3 SLAP repair

According to Snyder and Maffet, SLAP lesions can be classified into seven subtypes:

SLAP lesions (according to Snyder and Maffet)

- Type I: degenerative change of the superior labrum
- Type II: biceps anchor torn away from superior glenoid
- Type III: "bucket-handle" tear of the superior labrum with an otherwise intact biceps anchor
- Type IV: tear in the superior labrum with involvement of the biceps tendon
- Type V: SLAP II and additional Bankart lesion that merge together
- Type VI: SLAP II and additional instable labrum flap
- Type VII: SLAP lesion that continues into the middle glenohumeral joint

Table 2.7 Arthroscopic anteroinferior shoulder stabilization. Shoulder joint bandage (e.g. medi® SLING) for 24 hours, then for four weeks primarily at night and during longer walking load or activities

Phase	Range of motion and permitted load	
I	1st to 3rd weeks post-op:	Active abduction/adduction: 45°/0°/0° Active flexion/extension: 45°/0°/0° Active IR/ER: 80°/30°/0°
II	4th to 6th weeks post-op:	Active abduction/adduction: 90°/0°/0° Active flexion/extension: 90°/0°/0° Active IR/ER: 80°/0°/0°
	from 7th week post-op:	Free mobility
III	from approx. 7th week post-op:	Jogging
	approx. 3 months post-op:	Cycling
IV	approx. 4 months post-op:	Swimming (no raising arm above the head, e.g. no crawl or butterfly stroke)
	approx. 6 months post-op:	Sport-specific training
	approx. 9 months post-op:	Contact and high-risk sports (e.g. handball/ice hockey)

Table 2.8 Arthroscopic anteroinferior capsular plication. Shoulder joint bandage (e.g. medi® SLING) for three weeks, then at night for a further three weeks

Phase	Range of motion and permitted load	
I	1st to 3rd weeks post-op:	Passive abduction/adduction: 30°/0°/0° Passive flexion/extension: 30°/0°/0° Passive IR/ER: 80°/45°/0°
II	4th to 6th weeks post-op:	Active assisted abduction/adduction: 45°/0°/0° Active assisted flexion/extension: 45°/0°/0° Active assisted IR/ER: 80°/30°/0°
III	7th to 9th weeks post-op:	Active abduction/adduction: 90°/0°/0° Active flexion/extension: 90°/0°/0° Active IR/ER: free/0°/0°
	from approx. 7th week post-op:	Jogging
	from 10th week post-op:	Free mobility
	approx. 12 weeks post-op:	Cycling
IV	approx. 4 months post-op:	Swimming (no raising arm above the head, e.g. no crawl or butterfly stroke)
	approx. 6 months post-op:	Sport-specific training
	approx. 9 months post-op:	Contact and high-risk sports

Table 2.9 Arthroscopic posterior shoulder stabilization. Shoulder joint bandage in 0° rotation (e.g. medi® SLK) for three weeks, then at night for a further three weeks

Phase	Range of motion and permitted load	
	6 weeks post-op:	No horizontal adduction and no moving the arm behind the body
I	1st to 3rd weeks post-op:	Active assisted abduction/adduction: 45°/0°/0° Passive flexion/extension: 30°/0°/0° Active IR/ER: 30°/0°/60°
II	4th to 6th weeks post-op:	Active assisted abduction/adduction: 90°/0°/0° Active assisted flexion/extension: 60°/0°/0° Active IR/ER: 45°/0°/75°
III	7th to 8th weeks post-op:	Active abduction/adduction: 90°/0°/0° Active flexion/extension: 60°/0°/0° Active IR/ER: 60°/0°/free
	from 9th week post-op:	Free mobility
	from approx. 7th week post-op:	Jogging
	approx. 3 months post-op:	Cycling
IV	approx. 4 months post-op:	Swimming (no raising arm above the head, e.g. no crawl or butterfly stroke)
	approx. 6 months post-op:	Sport-specific training
	approx. 9 months post-op:	Contact and high-risk sports (e.g. ice hockey)

Table 2.10 Arthroscopic posterior and anterior shoulder stabilization with capsular shift. Shoulder joint bandage in 0° rotation (e.g. medi® SLK) for six weeks

Phase	Range of motion and permitted load	
	6 weeks post-op:	No horizontal adduction and no moving the arm behind the body
I	1st to 3rd weeks post-op:	Active assisted abduction/adduction: 45°/0°/0° Passive flexion/extension: 30°/0°/0° Active IR/ER: 30°/0°/0°
II	4th to 6th weeks post-op:	Active assisted abduction/adduction: 90°/0°/0° Active assisted flexion/extension: 60°/0°/0° Active IR/ER: 45°/0°/0°
III	7th to 8th weeks post-op:	Active flexion/extension: 90°/0°/0°, otherwise free
	from 9th week post-op:	Free mobility of the shoulders
	from approx. 7th week post-op:	Jogging
	approx. 3 months post-op:	Cycling
IV	approx. 4 months post-op:	Swimming (no raising arm above the head, e.g. no crawl or butterfly stroke)
	approx. 6 months post-op:	Sport-specific training
	approx. 9 months post-op:	Contact and high-risk sports

Indication

- Type I: conservative.
- Type III: arthroscopic labrum resection.
- Type II, IV-VII: arthroscopic refixation.

Surgical method

- Diagnostic arthroscopy via the standard posterior portal with assessment of pathology.
- Inserting an anterosuperior portal.
- **Type III lesion:** resection of the detached labrum.
- **Type II, IV-VII:** debridement of the edge of the glenoid and placement of suture anchor systems via the second lateral transspinous portal, depending on the location and extent of the lesion (Fig. 2.4).
- **Type V:** additional anterior stabilization via deep anterior portal via the above technique.

Aftercare

An overview of aftercare can be found in Table 2.11 and Table 2.12.

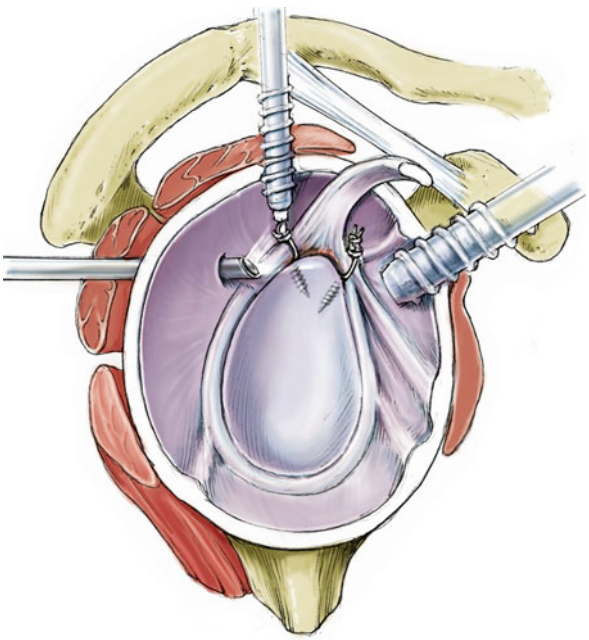


Fig. 2.4 Arthroscopic refixation of a SLAP II lesion with two bioresorbable suture anchors

2.2.4 AC joint reconstruction

Indication

- Acute AC joint dislocations type IV-VI according to Rockwood.

Table 2.11 SLAP II repair. Shoulder joint bandage (e.g. medi® SLING) every day for six weeks (apart from during treatment)

Phase	Range of motion and permitted load	
	6 weeks	No active bicep exercises
I	1st to 3rd weeks post-op:	Active abduction/adduction: 45°/0°/0° Passive flexion/extension: 45°/0°/0° Active IR/ER: 80°/0°/0°
II	4th to 6th weeks post-op:	Active abduction/adduction: 60°/0°/0° Passive flexion/extension: 90°/0°/0° Active IR/ER: 80°/0°/0°
	from 7th week post-op:	Free range of movement
III	from approx. 7th week post-op:	Jogging
	approx. 3 months post-op:	Cycling
IV	approx. 4 months post-op:	Swimming (no raising arm above the head, e.g., no crawl or butterfly stroke)
	approx. 6 months post-op:	Sport-specific training
	approx. 9 months post-op:	Contact and high-risk sports (e.g., handball)

Table 2.12 SLAP IV–VII repair. Shoulder joint bandage (e.g. medi® SLING) every day for six weeks (apart from during treatment)

Phase	Range of motion and permitted load	
	6 weeks	No active bicep exercises
I	1st to 3rd weeks post-op:	Active abduction/adduction: 45°/0°/0° Passive flexion/extension: 45°/0°/0° Active IR/ER: 80°/30°/0°
II	4th to 6th weeks post-op:	Active abduction/adduction: 60°/0°/0° Passive flexion/extension: 90°/0°/0° Active IR/ER: 80°/0°/0°
	7th to 8th weeks post-op:	Active abduction/adduction: 90°/0°/0° Active flexion/extension: free Active IR/ER: free
III	from 9th week post-op:	Free mobility
	from approx. 7th week post-op:	Jogging
	approx. 3 months post-op:	Cycling
IV	approx. 4 months post-op:	Swimming (no raising arm above the head, e.g., no crawl or butterfly stroke)
	approx. 6 months post-op:	Sport-specific training (e.g., throwing sports)
	approx. 9 months post-op:	Contact and high-risk sports

Surgical method

- Glenohumeral diagnostic arthroscopy via standard dorsal access with assessment and treatment for concomitant injuries (e.g. SLAP lesions).
- Insertion of an anterolateral portal and soft tissue preparation until the base of the coracoid process is visible.
- Approx. 2cm long skin laceration in the region of the lateral third of the clavicle and insertion of two drill channels via arthroscopic target device in the anatomical course of the coracoacromial ligament structures.
- Inserting a two-part Tight-Rope® cable system (Arthrex) and blocking under arthroscopic control. Potentially, biological augmentation through gracilis tendon transplant for chronic lesions.
- Tensing and tying the Tight Ropes® using arthroscopic and radiological repositioning checks. (Fig. 2.5)

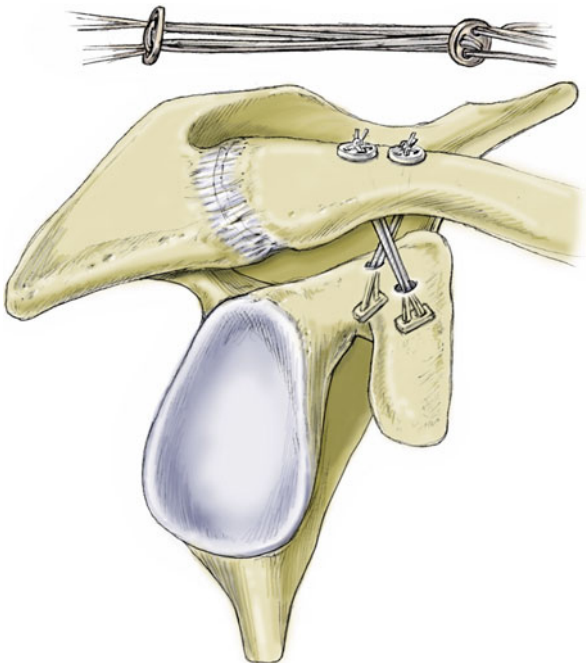


Fig. 2.5 Arthroscopic AC joint reconstruction with 2x Tight Rope® (Arthrex)

Aftercare

Table 2.13 provides an overview of aftercare.

2.3 Endoprosthesis

2.3.1 Total endoprosthesis (TEP), hemiprosthesis without glenoid replacement (HEP) and replacement of the humeral head (e.g. Eclipse®)

Indication

- Primary and secondary omarthroses with preserved rotator cuff (with and without glenoid involvement).
- Humeral head necroses.
- Omarthroses in young patients.

Surgical method

- Skin incision and preparation via delta split or deltoidopectoral access.
- Preparation and detachment of the subscapularis muscle.
- Exposing the humeral head and resection through prosthesis template.
- In the event of additional glenoid replacement, preparation and debridement of the glenoid.
- Adjusting the prosthesis while observing the soft tissue balance and fixation of the shaft or head replacement in the case of additional glenoid replacement, fixation of the glenoid with cement, or without cement with screws.
- Refixation of the subscapularis muscle.
- Wound closure layer by layer (Fig. 2.6, Fig. 2.7)

Table 2.13 Chronological phases in AC joint reconstruction. Shoulder joint bandage (e.g. medi® SLING) for six weeks

Phase	Range of motion and permitted load	
I	1st to 2nd weeks post-op:	Passive abduction/adduction: 30°/0°/0° Passive flexion/extension: 30°/0°/0° Passive IR/ER: 80°/0°/15°
II	3rd to 4th weeks post-op:	Active assisted abduction/adduction: 45°/0°/0° Active assisted flexion/extension: 45°/0°/0° Active assisted IR/ER: 80°/0°/15°
	5th to 6th weeks post-op:	Active abduction/adduction: 60°/0°/0° Active flexion/extension: 60°/0°/0° Active IR/ER: free
III	from 7th week post-op:	Free mobility
	from approx. 7th week post-op:	Jogging
	approx. 3 months post-op:	Cycling (adjusted choice of terrain)
IV	approx. 4 months post-op:	Swimming (no raising arm above the head, e.g. no crawl or butterfly stroke)
	approx. 6 months post-op:	Sport-specific training
	approx. 9 months post-op:	Contact and high-risk sports

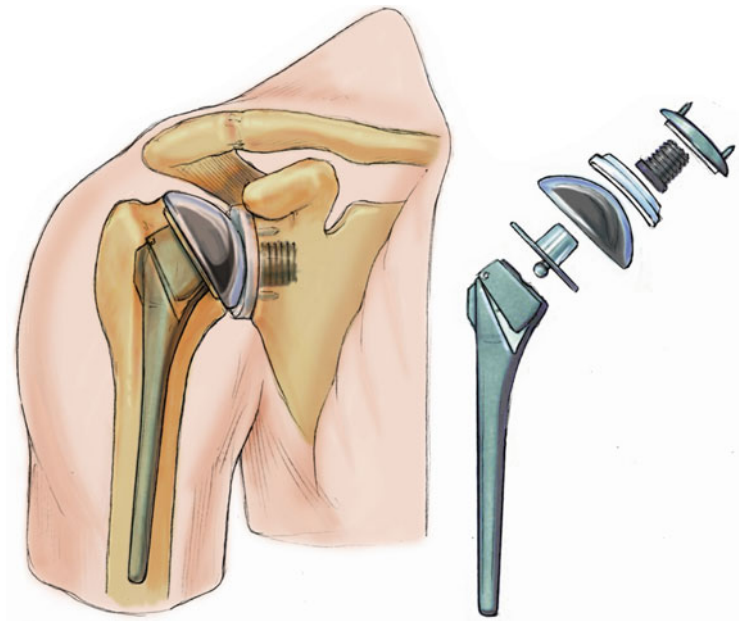


Fig. 2.6 Total endoprosthesis of the shoulder (Univers® variety, Arthrex)

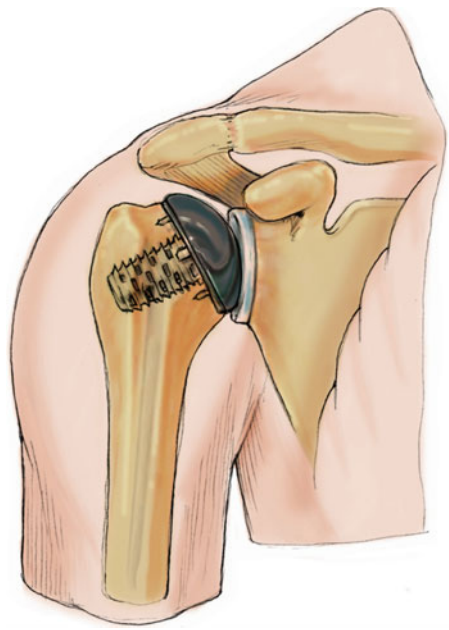


Fig. 2.7 Humeral head replacement (type Eclipse®, Arthrex) with glenoid replacement

Aftercare

Table 2.14 provides an overview of aftercare.

2.3.2 Shoulder endoprostheses, inverse

Indication

- Seconday omarthroses following rotator cuff ruptures (defect arthropathies).
- Non-reconstructable rotator cuff defects.

Surgical method

- Skin incision and preparation via deltoidopectoral access.
- Preparation and detachment of the subscapularis muscle (where still present).
- Exposing the humeral head and resection through template.
- Preparation and debridement of the glenoid.
- Adjusting the prosthesis while observing the soft tissue balance and fixation of the shaft with or without cement and fixation of the glenosphere (glenoid basis and inverse head) with hollow screw.
- Refixation of any potential parts of the subscapularis muscle.
- Wound closure layer by layer (Fig. 2.8)

Table 2.14 Should endoprosthesis (TEP, HEP, humeral head replacement) shoulder abduction orthosis in 15° abduction (e.g. medi® SAS Comfort) for six weeks

Phase	Range of motion and permitted load	
I	1st to 3rd weeks post-op:	Passive abduction/adduction: 90°/0°/0° Passive flexion/extension: 90°/0°/0° Passive IR/ER: 80°/0°/0°
II	4th to 6th weeks post-op:	Active assisted abduction/adduction: 90°/0°/0° Active assisted flexion/extension: 90°/0°/0° Passive IR/ER: free/0°/0°
III	from 7th week post-op:	Following clinical and radiological inspection: Approval of movement
	from approx. 7th week post-op:	Jogging/walking
IV	approx. 3 months post-op:	Cycling, swimming
		Contact and high-risk sports generally not recommended/individual therapy decision!

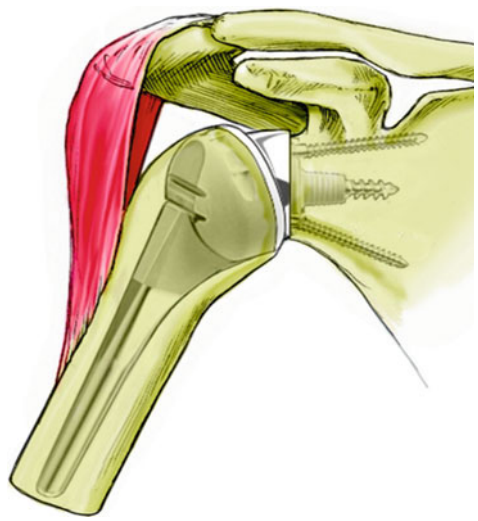


Fig. 2.8 Inverse shoulder endoprostheses (Univers®, Arthrex Inc.)

Aftercare

Table 2.15 provides an overview of aftercare.

2.4 Arthrolysis

2.4.1 Arthroscopic arthrolysis of the shoulder

Indication

- Frozen shoulder stages 3 and 4 (following fruitless conservative therapy).

Surgical method

- General anesthesia with scalene catheter.
- Insertion of a posterior and anterosuperior arthroscopy portal.
- Electrothermic detachment of the anterior and posterior capsular segments while controlling the mobility achieved (alternating between arthroscopic and instrument portals).
- Electrothermic detachment of potential growths in the area of the subscapularis muscle.
- Wound closure layer by layer.

Aftercare

Table 2.16 provides an overview of aftercare.

Table 2.15 Inverse shoulder endoprostheses. Shoulder abduction orthosis in 15° abduction (e.g. medi® SAS Comfort) for 3 weeks

Phase	Range of motion and permitted load	
	for 6 weeks post-op:	No active IR and no passive ER>0°
I	1st to 2nd weeks post-op:	Active assisted abduction/adduction: 60°/0°/0° Active assisted flexion/extension: 60°/0°/0° Passive IR/ER: 80°/0°/0°
II	3rd to 4th weeks post-op:	Active assisted abduction/adduction: 90°/0°/0° Active assisted flexion/extension: 90°/0°/0° Passive IR/ER: 80°/0°/0°
	from 5th week post-op:	Range of motion is approved
III	from approx. 7th week post-op:	Jogging/walking
IV	approx. 3 months post-op:	Cycling
		Contact and high-risk sports generally not recommended/individual therapy decision!

Table 2.16 Arthroscopic arthrolysis of the shoulder joint. Modified Gilchrist bandage for alternating positions in the initial days following surgery

Phase	Range of motion and permitted load	
I	Immediately post-op:	Alternating positions in modified Glichrist bandage in internal and extension in 90° abduction during the hospitalization phase (every two hours) No restriction of movement, intensive terminal passive exercise (multiple times per day) Instruction regarding independent activity
II		In the case of sufficient shoulder control, transition to active exercises, concentric/eccentric training of all muscles related to the shoulder girdle as well as instruction in independent training
III	from approx. 4th week post-op:	Jogging/walking, cycling, swimming, sport-specific training
IV	from approx. 3 months:	Contact and high-risk sports

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Shoulder: Rehabilitation

Andreas B. Imhoff, Knut Beitzel, Knut Stamer, Elke Klein

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3.1 Phase I

Goals (in accordance with ICF)

Goals of phase I (in accordance with ICF)

- **Physiological function/bodily structure:**
  - **Pain relief**
  - **Promoting resorption**
  - **Retaining/improving joint mobility**
  - Regulation of impaired vegetative and neuromuscular functions
  - Improving joint stability
  - Avoiding functional and structural damage
  - Improvement in functions affecting sensorimotor function
  - Learning the optimum scapula position and to center the humeral head
- **Activities/participation:**
  - Carrying out daily routine with pressure relieved on the arm that underwent surgery
  - Promoting mobility (maintaining and changing body position, walking and movement, lifting and carrying objects)
  - Breaking down barriers that impede participation (anxiety...)

3.1.1 Physiotherapy

Patient education

- Discussing the content and goals of treatment with the patient.
- Pain management with the goal of becoming pain-free (physiological pain processing):
  - Treatment should take place within the pain-free range.
  - Keep in pain-free positions, especially at night (e.g. supporting the arm with cushions in dorsal and lateral position).
- Position control: The arm should be held in front of the body at scapular level, with the elbows in front of the body. When lying down, the arm is supported with a cushion dorsally at the humerus (Fig. 3.1).
  - **Latissimus dorsi transfer:** Through the strict immobilization in a thorax abduction cast for six weeks, it is particularly important to check the precise position/insertion. The arm should be supported under no pressure with shoulder and neck muscles as relaxed as possible.
  - **Arthrolyses:** Patient compliance and sufficient analgesia are of particular importance here to ensure that the treatment and holding of the shoulder/elbow involves as little pain as possible and that the patient is able to consistently perform their exercises independently. The position of the shoulder joint in the case of arthrolysis is led into IR and ER alternately from 90° abduction position. (**Tip:** improving posture using beanbags) (Fig. 3.2).
- Informing the patient about his/her personal shoulder pathology using visual aids (mirror, shoulder model, etc.), tactile support and verbal feedback. If the patient understands the problem, they will be much more motivated and willing to cooperate!
- Providing the patient with further information regarding the limitations associated with the operation:
  - Raising the arm
  - Carrying weights
  - Supporting yourself on your hand or elbow
  - Rapid, abrupt movements.

Prophylaxis

- Pneumonia and thrombosis prophylaxis through:
  - Early mobilization from bed.
  - Instruction on SMI trainer, deep breathing techniques such as nose stenosis, "sniffing" inhalation or breathing control. Active terminal movement in the ankle joints at second intervals.
  - Activating the muscle pump by firmly opening and closing the hand or, under free elbow mobility, actively moving the elbow joint within all degrees of freedom. This is independently carried out by the patients as aerobic local endurance training each hour.

Promoting resorption

- Activating the muscle pump by firmly opening and closing the fist.
- Active movement of the elbow joint (**Cave:** SLAP refixations and LBT tenodesis).

Fig. 3.1 Continuously checking the position of the arm

Fig. 3.2a,b Improving posture using beanbags

- Supporting the arm above heart height.
- Manual lymph drainage.
- Hot rolls on the segment.

Improving mobility

- Passively or actively assisted movement of the joint based on the procedure. Potentially sling table for lift-free/reduced-lift mobilization.
- Retaining mobility: mobilization of the glenohumeral joint via scapula mobilization:
  - Scapula pattern while sitting or in lateral position,
  - Dynamic mobilization in lateral position, e.g., in medial rotation direction, adduction.
- Improving the mobility of the neighboring joints: hand and elbow.
- Manual therapeutic measures, depending on findings: occiput-atlas-axis complex (OAA), cervical spine, thoracic spine, AC joint, sternoclavicular articulation, rib joints.
- Counter-bearing mobilization from the functional kinetics method (Suppé 2007) (Fig. 3.3).
- Soft-tissue treatment of the muscles through techniques such as MET, INIT, reciprocal inhibition, functional massage, PIR:
  - Levator scapulae muscle

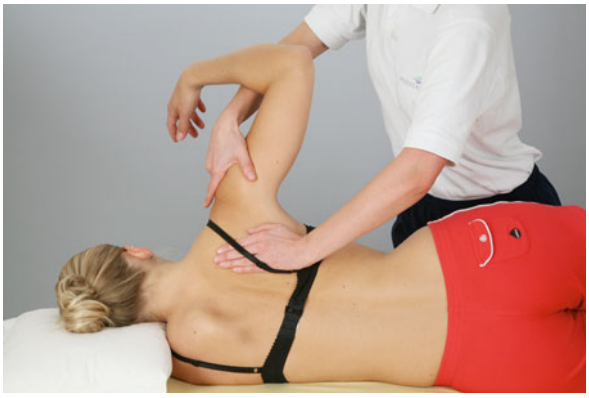


Fig. 3.3 Counter-bearing mobilization

  - Descending part of the trapezius muscle
  - Pectoral muscles
  - Biceps brachii muscle
  - Latissimus dorsi muscle
  - Elbow extensor group
  - Occipital muscles
- Instruction into independent mobilization:
  All independent exercises require the patient to be able to control the shoulder position when at rest and when exercising!
  - **Shoulder stabilization:** To actively control the scapula position, the patient should hold a tennis ball against the wall with the scapula and depending on the permitted degree of activity, actively move the arm or with assistance within the permitted range of motion in flexion, abduction and rotation (Fig. 3.4).

Fig. 3.4 Shoulder stabilization with tennis ball

Fig. 3.5 Wiping motion exercise sitting in front of the bench with rolling pin

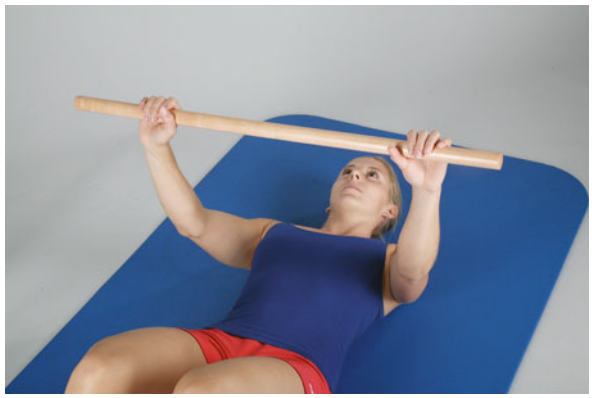


Fig. 3.6 Mobilization of the shoulder with bar

- **Rotator cuff repairs, prostheses:**
  Mobilization using a pulley, with the arm that underwent surgery being brought passively into flexion or abduction.
  Wiping movement exercise sitting in front of the bench: the hands are lain on a towel, that is then moved backwards and forwards; alternatively, a rolling pin can be used (Fig. 3.5).
- **Shoulder joint arthrolysis:** patients mobilize the shoulder joint using a bar in supine position, lateral position (Fig. 3.6).

Practical tip

In the case of **arthrolysis**, targeted manual joint mobilization techniques are recommended to improve the elasticity of the joint capsule (MT level 3, against resistance!). It is important for the patient to be provided with sufficient analgesics, especially during treatment times!

- Low-lift mobilization options in exercise pool: The patient stands in water and is stabilized with the aid of rubber reins that are placed around the pelvis. By leaning the patient forward horizontally, the arm becomes more and more elevated. For the advanced: horizontal position in water with feet on the wall, using a snorkel and diving goggles.

Regulation of vegetative and neuromuscular functions

- Treatment in the orthosympathetic and parasympathetic areas of origin Th1-Th8, OAA complex:
  - Manual therapy (MT), mobilization of the thoracic spine, mobilization of the rib joints
  - Physical therapy: massage, hot rolls, electrotherapy etc.
- Passive movement within pain-free range, traction and compression from MT as stimulus for the regeneration of the synovial membrane of the joint capsule.
- Manual therapy in the nervous area of origin of the shoulder-arm muscles C5-C8.

Improving sensorimotor function

- Minimal traction and compression level 1 from MT as afferent sensomotory input.
- Overflow and facilitation techniques from the PNF concept via the core and the extremities that did not undergo surgery, e.g. scapular patterns while sitting (Fig. 3.7).

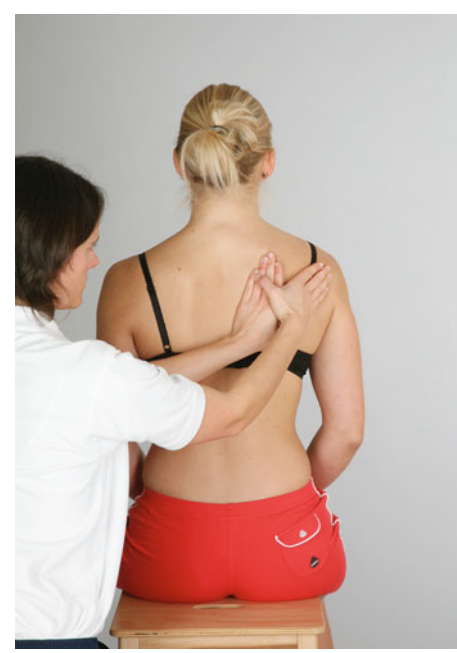


Fig. 3.7 Scapular pattern while sitting

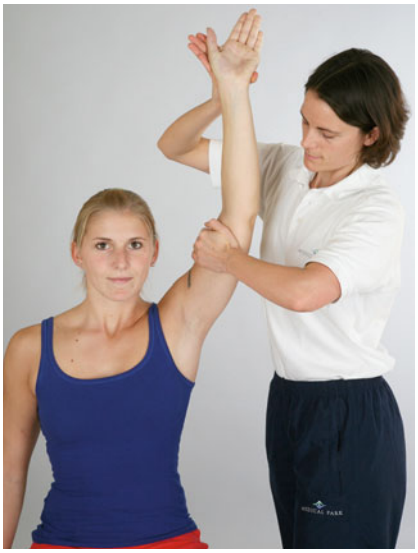
Practical tip

Working on arm raising

- The movement process of arm raising is divided into sequences, and the individual movement components are performed in isolation.
  - Example: the static centering of the humeral head is first of all achieved by holding the arm at scapula level. Followed by this being exercised dynamically, e.g. with negative weight on a cable pulley.
- It is then integrated into the entire movement process of "arm raising".

Stabilization and strengthening

- Developing the scapular setting (static control) as a stable basis for physiological movement in terms of perception training with tactile, visual (in front of a mirror) and verbal aids. Use of EMG.
- Beginning active humeral head positioning (▶ Section 3.2.1).
- Improving the sliding components of the humeral head caudally, while sitting, manually or with guided contact.
- Facilitating physiological humeral head centering, e.g., via
  - Arm/scapula pattern in flexion-abduction-ER on contralateral side (◘ Fig. 3.8).
  - Leg pattern in flexion-adduction-ER (free leg activity on the contralateral side facilitates supporting arm activity ipsilaterally).



◘ **Fig. 3.8** Facilitating physiological humeral head centering via arm/scapula pattern in flexion-abduction-ER on contralateral side

- Activation of the scapula-stabilizing muscles, especially ascending and transverse parts of trapezius, serratus anterior muscle, rhomboid muscles in various starting positions. Going to vertical as quickly as possible.
- Developing core stability.
- Exercises of the extremities not affected using the cable pulley or Vitality® band (physician's Vitality® band).

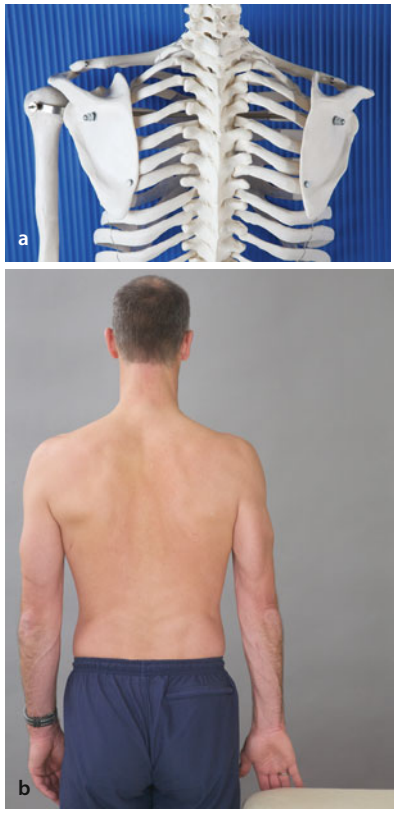
Scapular setting

Optimum position of the left scapula on the thorax when sitting or standing (◘ Fig. 3.9)

- The humeral head should not be more than 1/3 ahead of the acromion
- The medial border of the scapula is parallel to the spinous processes
- The spine of scapula cross at Th4 level
- The inferior angle is located at Th7 height
- The scapular level is rotated 30° from frontal level in ventral direction with a neutral thoracic spine

Physical measures

- Hot rolls.
- Massage, especially of the shoulder-neck muscles.



◘ **Fig. 3.9a,b** Scapular setting. **a** Optimum position of the left scapula on the thorax while sitting, **b** Low row isometrically

Fig. 3.10 CPM shoulder movement cast

- Manual lymph drainage (MLD).
- Coolpacks® or Cryocuff® as gentle cooling.
- Cryokinetics.
- CPM (continuous passive motion) shoulder movement cast: within the permitted range of motion: approx. six hours per day in repeated applications (Fig. 3.10).

During the application of CMP, the patient must control the scapular setting with an upright spinal posture and mentally follow the passive movements.

3.2 Phase II

Goals (in accordance with ICF)

Goals of phase II (in accordance with ICF)

- **Physiological function/bodily structure:**
  - **Promoting resorption**
  - **Retaining/improving joint mobility**
  - **Improving joint stability**
  - **Improvement in functions affecting sensorimotor function**
  - **Regulation of impaired vegetative and neuromuscular functions**
  - Pain relief
  - Improving muscular strength functions
  - Avoiding functional and structural damage
  - Learning scapular setting and to center the humeral head
- **Activities/participation:**
  - **Going about the daily routine (housekeeping, personal hygiene, acquiring basic necessities)**
  - Correcting posture (developing ergonomic posture/working posture)
  - Mobility (walking, carrying/lifting objects, arm/hand use)
  - Participation in the life of the community
  - Following a home training program independently

3.2.1 Physiotherapy

Patient education

- Discussing the content and goals of treatment with the patient.
- Making the patient aware of the permitted extent of movement in accordance with the procedure.
- Pain management with the goal of becoming pain-free (physiological pain processing):
  - The treatment/movement should take place within the pain-free range.
  - Keep in pain-free positions, especially at night (e.g. supporting the arm with cushions in dorsal and lateral position).
- Position control.
  - **Latissimus dorsi transfer:** monitoring the arm in the plaster. Can the shoulder girdle muscles relax? Do paresthesia or pressure points exist?
- Providing the patient with further information regarding the limitations associated with the operation:
  - Raising the arm
  - Carrying weights
  - Supporting yourself on your hand or elbow
  - Rapid, abrupt movements.
- Informing the patient about his/her personal shoulder pathology using visual aids (mirror, shoulder model) tactile support and verbal feedback. If the patient understands the problem, they will be much more motivated and willing to comply with load and exercise requirements!

Post-operative restrictions in movement frequently also arise as a result of a fear of movement and the reflexor protective tension of the muscles!

- Putting on and removing clothes independently, personal hygiene as well as eating should be possible without putting the shoulder at risk of injury. (Practice activities with the patient to build his/her trust.) At the same time, provide information regarding

changes in loads on the body's structures due to the phases of wound healing. Motivate the patient to stick to load and exercise plans, but also to work within these limits.

Practical tip

In the case of **arthrolysis**, the treatment goals should be discussed thoroughly with the patient. Without independent exercise each day, there is a risk of the shoulder stiffening again!

Prophylaxis

- Pneumonia and thrombosis prophylaxis (depending on the general condition of the patient).

Promoting resorption

- Activating the muscle pump by firmly opening and closing the fist.
- Active movement of the elbow joint. **Cave:** Not for six weeks in the case of SLAP fixations and LBT tenodesis!
- Manual lymph drainage.
- Observing the venous outflow routes and potentially treatment of bottlenecks: detonization of the scaleni and pectoralis minor muscles, mobilization of the first rib, clavicle.

Improving mobility

- Passive, actively assisted or active movement within the pain-free range, taking the three-dimensional movement behavior of the shoulder within the permitted range of motion into account.
- Mobilization of the shoulder girdle in different starting positions, e.g. modified counter-bearing mobilization in accordance with Klein-Vogelbach in lateral position under active posterior depression of the shoulder girdle with simultaneous passive elevation or abduction of the arm by the therapist. Mobilization of the scapula in medial rotation with arm pre-set in various flexion and abduction positions.
- Manual therapy: careful sliding of the humeral head caudally and dorsally (arthrokinematic mobilization). **Cave:** Stabilization!
- Sling table for lift-free/reduced-lift mobilization.
- Retaining the mobility of the neighboring joints: hand and elbow.
- Improvement the joint mobility in accordance with findings through manual therapeutic measures (OAA, cervical spine ◘ Fig. 3.11a, thoracic spine ◘ Fig. 3.11b, ACG, sternoclavicular articulation, rib joints).

◘ **Fig. 3.11a,b** Improving joint mobility. **a** Cervical spine, **b** Thoracic spine

- Soft tissue treatment:
  - Muscles using the techniques of MET, reciprocal inhibition, functional massage, INIT (◘ Fig. 3.12a,b), Strain-counterstrain, PIR:
    - Levator scapulae muscle
    - Descending part of the trapezius muscle
    - Scaleni muscles
    - Pectoral muscles (◘ Fig. 3.12c)
    - Biceps brachii muscle
    - Latissimus dorsi muscle
    - Sternocleidomastoid and occipital muscles (◘ Fig. 3.12d).
  - Fasciae treatment with release techniques, pressure and stretching:
    - Treatment of stomach, liver or spleen fascia or diaphragm depending on findings,
    - Mobilization of the neck and shoulder fasciae (◘ Fig. 3.13).
- Instruction into independent mobilization:
  - Starting in supine position: assistive flexion via bar or with folded hands (◘ Fig. 3.14)
- Standing in front of the bench with forearms resting on the bench: standing in front of bench, switching between a fixed end and b mobile end (now scapula) to mobilize flexion (◘ Fig. 3.15).

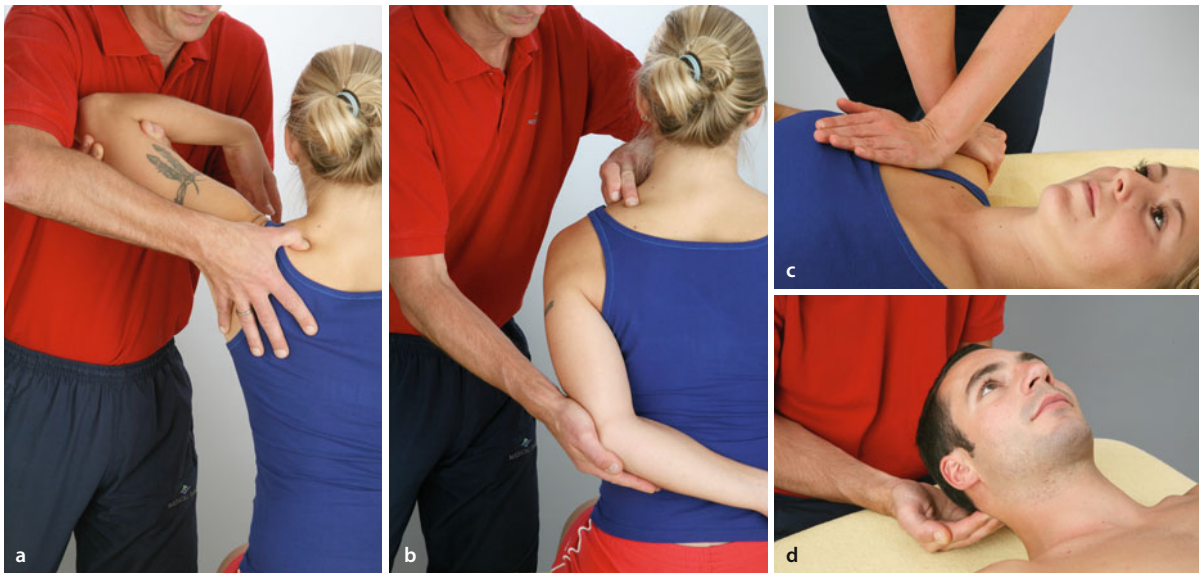


Fig. 3.12a–d Soft tissue treatment using the INIT technique (**a**,**b**), Pectoral muscles (**c**), Sternocleidomastoid and occipital muscles (**d**)

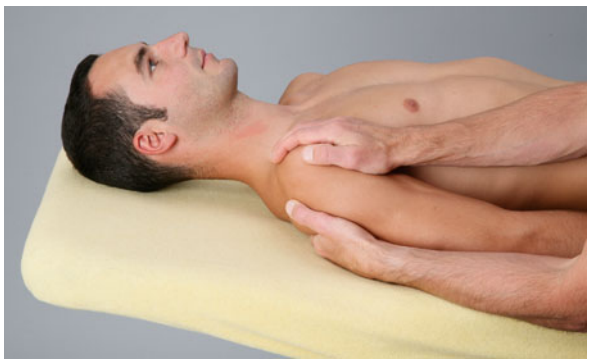


Fig. 3.13 Fascia treatment: mobilization of the shoulder fasciae

Fig. 3.14 Instruction into independent mobilization: assistive flexion with folded hands

- Pulley for flexion, abduction in combination with external rotation
- Independent mobilization with bar (Fig. 3.16)
- "One-armed bandit" to mobilize external rotation (Fig. 3.17)
- Independent mobilization of the thoracic spine using a mobilization wedge in supine position or sitting
- Option for at home: put two tennis balls in a sock and place under the spinal segment to be mobilized (Fig. 3.18):
  a. Blocking the lumbar spine (activate legs) to prevent further movement
  b. Making contact
  c. Minimal mobilization parallel to the facet level, dorso-cranially.

Practical tip

In the event of **arthrolysis**, intensive, targeted manual mobilization of the glenohumeral joint through traction and compression as well as translational and angular mobilization techniques to improve the elasticity of the joint capsule is recommended: MT level 3 (against resistance!), Maitland level 4 (Fig. 3.19).
It is not possible to avoid pain in this case! The patient should be given sufficient painkillers before treatment.
Cave: Here, the three-dimensional movement behavior of the shoulder is to be considered.

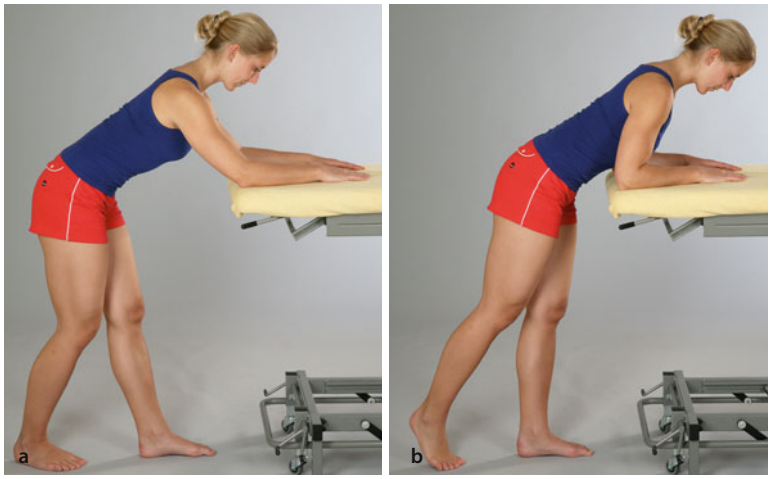


Fig. 3.15a,b Instruction into independent mobilization: standing in front of bench, switching between **a** Fixed end and **b** Mobile end (now scapula) to mobilize flexion

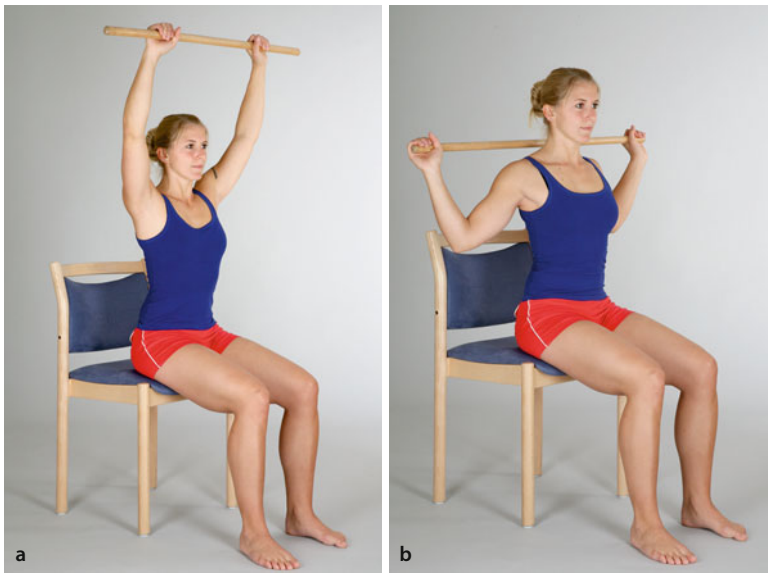


Fig. 3.16a,b Independent mobilization with bar

Regulation of vegetative and neuromuscular functions

- Treatment for functional disorders in the key areas:
  - OAA complex (Occiput-atlas-axis)
  - Cervicothoracic transition
  - Vertebrae Th1–Th5; ribs 1–5
  - Thoracolumbar transition.
- Treatment in the orthosympathetic and parasympathetic areas of origin (Th1-Th8, OAA complex) depending on findings.
- Mobilization of ribs 1-5.
- Mobilization of the cervicothoracic transition.
- Manual therapy in the nervous area of origin of the shoulder-arm muscles (C5-C8).
- Treatment of potential trigger points with techniques in accordance with Simons/Travel or INIT: Trapezius muscle, subscapularis muscle (not in the case of reconstructions of the subscapularis muscle).
- Treatment of neurolymphatic and neurovascular reflex points:
  - Infraspinatus muscle
  - Teres minor muscle
  - Subscapularis muscle
  - Serratus anterior muscle
  - Latissimus dorsi muscle.

Fig. 3.17 "One-armed bandit" to mobilize external rotation

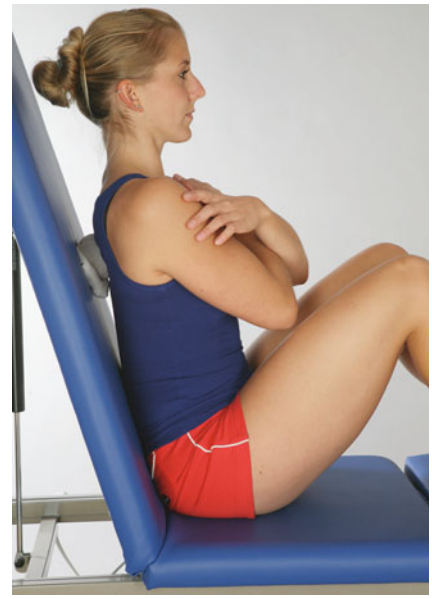


Fig. 3.18 Independent mobilization of the thoracic spine

Practical tip

Neurolymphatic reflex points for which treatment is indicated are to be distinguished from the surrounding tissue through palpation. They are usually painful and feel doughy, edematous and swollen.

- **Treatment:** a massage to the area without too much pain for at least 30 seconds. For very painful areas, start with gentle pressure and gradually increase pressure. A reduction in sensitivity should result from the treatment.

Neurovascular reflex points are not as noticeable upon palpation as NLR, but can be detected by the therapist.

- **Treatment:** determine NVR with two or three fingertips and gently move in different directions. The direction with the greatest tension, or where pulsation can be detected, is held for 30 seconds.

Improving sensorimotor function

- Minimal traction and compression level 1 from MT as afferent sensomotory input.
- PNF concept: overflow and facilitation techniques via the core and the extremities that did not undergo surgery.
- Perceiving scapula and shoulder position as well as torso position by:
  - Visual monitoring with mirror
  - Tactile assistance
  - Learning to correct oneself.

Fig. 3.19 Targeted manual mobilization of the glenohumeral joint in the event of arthrolysis

- Repositioning: therapist prescribes the position of the arm. Patient must adjust the position with his/her eyes closed.
- Inhibition of incorrect muscle recruitment in movement processes due to pre-operative pathologies in the muscle loops, e.g., pectoralis major and minor muscles, latissimus dorsi muscle and trapezius muscle. Then strengthening the antagonists through:
  - Visual checking via mirror
  - Biofeedback via surface EMG (Fig. 3.20)
  - Tactile assistance via hand contact
  - Tape to facilitate muscular activity, e.g., on the serratus anterior muscle.
- Initiating support function, i.e., without bearing weight, in closed system: facilitation of the coactiva-

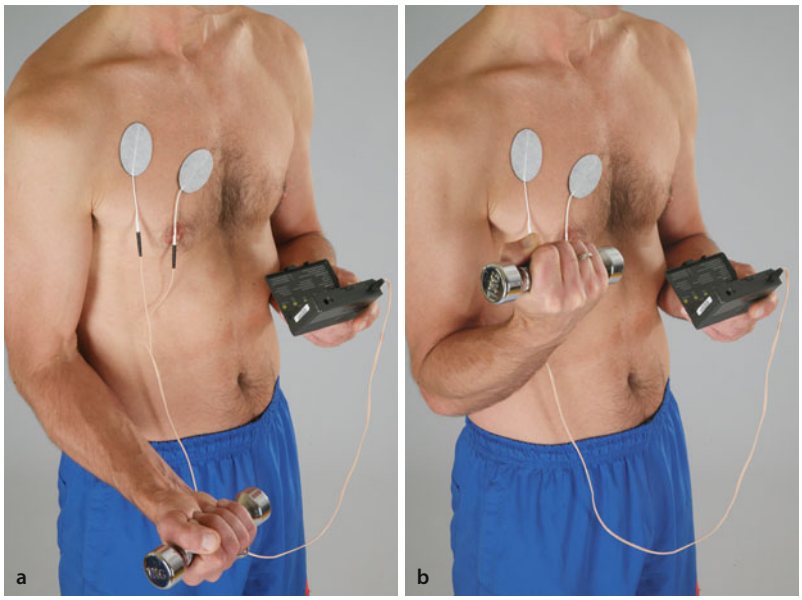


Fig. 3.20a,b Strengthening the antagonists through biofeedback via surface EMG

Fig. 3.21 Initiating the support function with Pezzi ball: Starting in prone position in overhang

Fig. 3.22 Facilitating the rotator cuff through guided contact on the carpal bones to coactivate the rotator cuff and scapula fixators

tion of the muscles of the rotator cuff and scapular fixators:
  - Starting position: sitting in front of the bench, arm supported at scapula level. The therapist provides guided contact on the carpal bones. Alternatively, the patient's hand can be held against the bench, a ball or the wall. Focus on controlling scapular position and humeral head centering!
  - Starting in prone position in overhang: plank on a Pezzi ball (Fig. 3.21).
- Facilitating the rotator cuff through guided contact on the carpal bones to coactivate the rotator cuff and scapula fixators (Fig. 3.22).
- Initiating the grip function (Fig. 3.23).

In the case of pectoralis major transfer
- Activation of muscular function.
- Mental training in cast as innervation training – functional change in the muscle (cognitive phase of motor learning).

In the case of latissimus dorsi transfer
- Reprogramming muscular function from adductor/internal rotator to abductor/external rotator.
- Mental training in cast as innervation training (cognitive phase in the process of motor learning).
- Awareness training of the core and shoulder:
  - Inhibition of incorrect muscle recruitment due to pre-operative pathologies (e.g. pectoralis major

Fig. 3.23 Initiating the grip function

Fig. 3.24 Plank on unstable support surfaces in the case of arthrolysis

Fig. 3.25a,b Gyrotonic

muscle, latissimus dorsi muscle and trapezius muscle) with use of
- Visual checking via mirror
- Biofeedback via surface EMG
- Tactile assistance
- Tape.

Goal-oriented movement enables the feed-forward innervation of the primary stabilizing muscles (stabilizers). Movement exercises should therefore be performed in everyday situations.

In the event of arthrolysis

- Closed system work-out:
  - Starting in prone position:
    - Plank on Pezzi ball
  - Starting in quadrupedal position:
    - Plank on unstable support surfaces (Fig. 3.24)
    - Raising the extremities alternatively
    - Plank on Posturomed in quadrupedal position, bear stance
  - Starting in standing position:
    - Propriomed/bodyblade with one or two hands on all levels, statically and while moving
    - More advanced: standing on unstable support surface
- Push-ups on unstable support surface.
- Gyrotonic (Fig. 3.25)
- Stabilization in the Redcord® system.

Stabilization and strengthening

- Further developing the scapular setting (static control) as a stable basis for physiological movement in terms of perception training with tactile, visual (e.g. mirror) and verbal aids.
- In the case of sufficient awareness of the shoulder position in rest position and sufficient sense of movement, a transition can be made to dynamic scapular stabilization, e.g., under diminished weight while sitting:
  - In front of the bench, forearms or hands resting on a skateboard: controlling flexion
  - Hands on a ball: flexion and extension to neutral position by rolling the ball backwards and forwards (Fig. 3.26)

In dynamic scapula stabilization, the balance of the muscle loops between scapula and torso is of particular significance, so that the optimum position of the scapula on the torso or a coordinated scapular movement can be guaranteed when moving the glenohumeral joint.

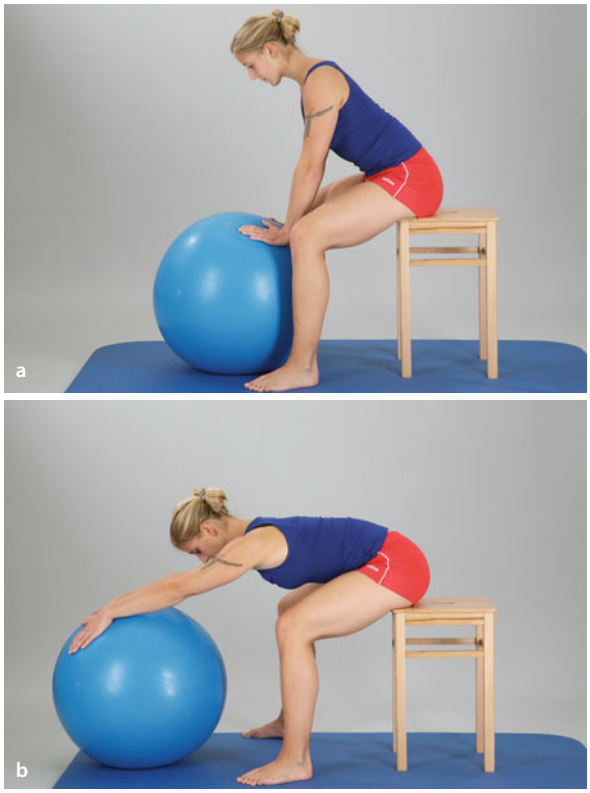


Fig. 3.26a,b Stabilization and strengthening. **a** Flexion and **b** Extension to neutral position by rolling the ball backwards and forwards

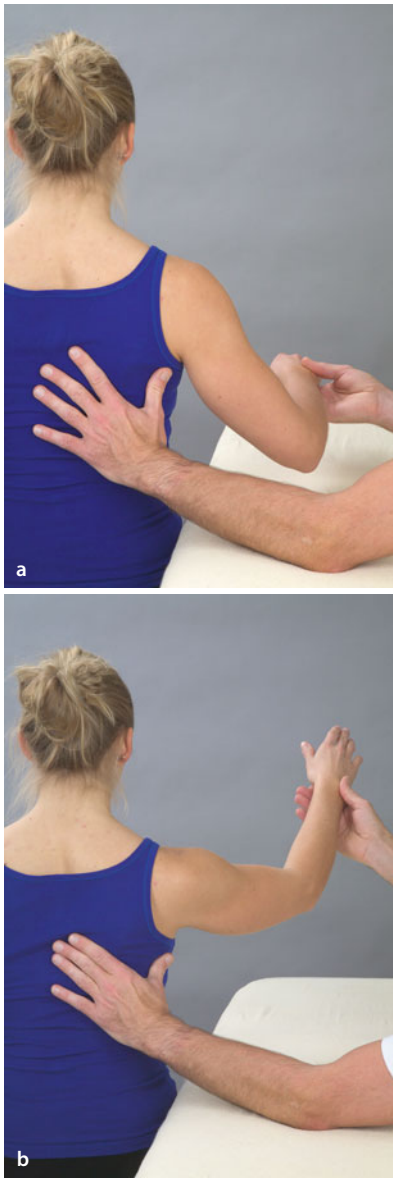


Fig. 3.27a,b Dynamic scapular stabilization. Tactile support in controlling the serratus anterior muscle along the lateral side of the inferior angle for the lateral rotation of the scapula

Muscle loops and their directions of movement

- Levator scapulae – ascending part of the trapezius muscle: controlling elevation/depression
- Serratus anterior - transverse part of the trapezius: controlling abduction/adduction
- Pectoralis minor – descending part of the trapezius muscle: controlling shifting dorsocranially/ventero-caudally
- Rhomboid – serratus anterior: controlling rotation (Hochschild 2002)

- Training scapulothoracic rhythm starting position: sitting, arm at scapula level resting on the bench:
  - Begin with awareness of posture, shoulder and scapular position with visual checks using a mirror: displaying the actual and target position
  - Tactile support in controlling the ascending part of the trapezius muscle on the spinal triangle during elevation. The patient activates the muscles in the direction of the tactile stimulus.
  1. Static: the arm of the patient is at scapular level.
  2. Dynamic: the patient guides the arm assisted/actively into elevation (idea: the arm is an opening gate, the scapula is the counterweight at the end of the gate and is falling – while the arm is guided into elevation, the scapula remains on the thorax)
  - Tactile support in controlling the serratus anterior muscle along the lateral side of the inferior angle for the lateral rotation of the scapula (Fig. 3.27).
- Support training program:
  - Wall press
  - Push-up
  - One-armed push-ups
  - Bench press plus (bench press with scapular protraction).

Feedback is provided by the therapists. Too many corrections impede the learning process! Give the patient time to do the practice exercises! In the motor learning model, this corresponds with the associative phase: Individual movement components are associated with success and failure and should be retained or modified accordingly; the patient develops a strategy to solve the task (sensorimotor and motor areas are active).

Automation is the true goal of learning: Deliberate control is no longer needed in the performance of movements.

- Treatment methods from the PNF concept:
  - Scapula pattern in various starting positions with "combination of isotonics" techniques (changing between dynamic-concentric, dynamic-eccentric and static muscle activity in an agonistic pattern to improve intramuscular/intermuscular coordination and to recruit motor units)
  - Arm pattern with dynamic rotation techniques (concentric working out of the agonists and antagonists alternatively)
  - Independent practical exercise for the patient at home: rolling pin or tea towel on smooth table for a wiping motion with both hands. Balancing a coffee cup on a saucer trains connecting the scapula to the core (Fig. 3.28)
  - Starting in seated position, standing: practice flexion-adduction-ER with the contralateral arm in PNF pattern → results in an automatic attachment of the scapula to the core when walking on the ipsilateral side (activity of the ascending part of the trapezius muscle, anterior serratus muscle)
  - Static and dynamic training of the muscles attached to the scapula (Fig. 3.29)
  - Exercises of the extremities not affected using the cable pulley or Vitality® band
  - Working with unstable support surfaces, such as sitting on a Pezzi ball or aball cushion with additional resistance.

Important factors for coordinated scapular movement are:

1. **Balanced coactivation in the muscle loops**
2. **Correct training of scapular rotator activity**
3. **Level to which the corresponding muscle is activated during movement**

- Humeral head centering:
  - If the central position can be maintained statically at scapular level, the patient can shift into it so that it can be modified into various joint positions. A further more advanced option is holding the centering statically and giving the patient additional tasks.

Fig. 3.28 Connecting the scapula to the core by balancing a coffee cup on a saucer

Fig. 3.29 Static and dynamic training of the muscles attached to the scapula

Practical tip

Pre-requisites for humeral head centering:

- Straightening the cervical spine and thoracic spine
- Scapula setting: see phase I (▶ Section 3.1.1)
- Sufficient mobility of the glenohumeral joint

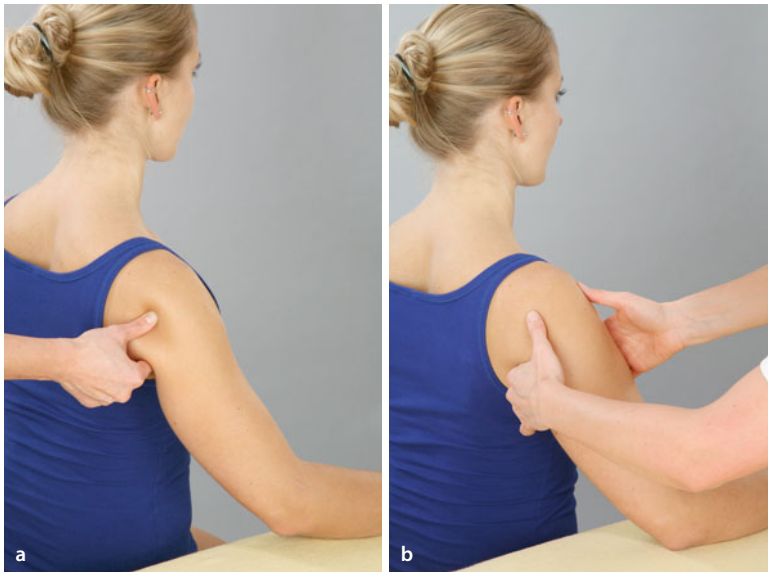


Fig. 3.30a,b Humeral head centering. **a** Manual guided contact dorsocadually on the humeral head, **b** Alternative: With both hands, create traction level 1 at a 90° angle to scapular level proximally to the humeral had or lengthways along the humeral shaft. The patient should imagine that his/her glenoid is a vacuum cleaner nozzle which s/he can use to suck the humeral head into the articular cavity. The pect. maj. and latissimus dorsi muscles should not be tensed here

Approach:

- Starting position: supporting the arm at scapula level (best activation of the rotator cuff)
- Manual guided contact dorso-caudally on the humeral head (Fig. 3.30a)
- Alternatively: With both hands, create traction level 1 at a 90° angle to scapular level proximally to the humeral had or lengthways along the humeral shaft. The patient should imagine that his/her glenoid is a vacuum cleaner nozzle which s/he can use to suck the humeral head into the articular cavity (Fig. 3.30b). The pect. maj. and latissimus dorsi muscles should not be tensed here

More advanced:

- Holding the arm in different allowed joint positions. Begin statically and, if the patient is able to keep his/her balance well, moving onto a dynamic exercise. Short lever!
  (Additional tasks via contralateral arm while at the same time holding the humeral head in a centered position)

- Developing core stability (Fig. 3.31):
  - Strengthening the abdominal and back musculature, isolated and in the kinetic chain (Fig. 3.32)
  - Segmental stabilization HWS/LWS (▶ Section 19.2.1).

Fig. 3.31 Developing core stability

  - Stabilization via activation of deep neck flexors (▶ Section 17.2.1).

A stable core is required as a necessary basis that allows shoulder function to be developed through further rehabilitation. From a dorsal perspective, the connection of the scapula to the core is important to transport the energy generated in the lower extremity to the distal segment of the arm. For the ventral musculature, the function of the lower abdominal muscles that provide the necessary stability in the pelvis in particular are of greater significance.

Fig. 3.32a,b Strengthening the abdominal and back musculature, **a** In isolation and **b** In the kinetic chain

- Correcting posture: Pay particular attention to the position or segmental stability of the spine. Shoulder pathology is often accompanied by insufficient core stability.
- Strengthening of the abdominal oblique muscles to stabilize the ribs in the core (Fig. 3.33).
- Starting in supine position: stabilization of cervical spine/thoracic spine with isometric stabilization of the shoulders in Redcord® system.

In the event of arthrolysis

- Training scapulothoracic rhythm: Should the patient's perception of their shoulder position in rest position and sense of movement be good enough, the transition can be made to dynamic scapula stabilization:
  - Pulley: The side that underwent surgery is drawn into flexion or abduction active-assistedly via the side that did not undergo surgery
  - Strengthening the abdominal muscles
  - Starting in lateral position in thrust pattern: The higher arm is supported against the therapist or the wall. The patient rolls the pelvis ventrally and dorsally
  - Starting in forearm plank and tiptoes: shifting the entire body in cranial and caudal direction

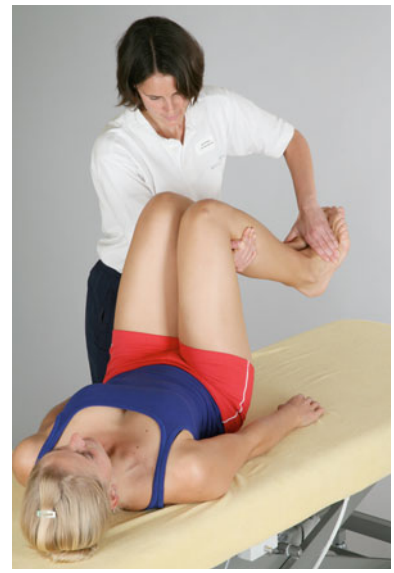


Fig. 3.33 Strengthening of the abdominal oblique muscles to stabilize the ribs in the core

  - Frog from the functional kinetics concept
  - Starting in prone position on Pezzi ball: upper body hold; squat
- Propriomed: with one or two hands on all levels, statically and dynamically. More advanced option: standing on unstable support surface
- Working in chains via the three-dimensional adjustment of the movement via techniques. Rhythmic stabilization, dynamic turnaround (short arm patterns, non-terminal position in lateral position and while sitting)
- Strengthening the muscles attached to the scapula
- Training the musculature centered round the humeral head:
  - Cable pulley ER (Fig. 3.34)
  - Starting in lateral position: ER
  - Starting in prone position: ER in 90° abduction

In the case of endoprosthetics

- In the case of the inverse prosthesis, the training of the deltoid muscle with all three sections forms the focus from the very beginning. In this phase, exercise takes place against gravity within the pain-free range.

Physical measures

- Hot rolls, e.g., in the sympathetic supply area to improve the metabolic status.
- Massage: shoulder-neck muscles and removal of adhesives from the scapulothoracic joint.
- Manual lymph drainage.
- Cryokinetics.

Fig. 3.34 Training the musculature centered round the humeral head in the event of arthrolysis: cable pulley ER

- Cool packs or Cryocuff as gentle cooling system.
- Stimulating local blood circulation through electrotherapy (diadynamic currents, ultrasound, massage, flat connective tissue massage. (**Cave:** Endoprostheses!)
- Treatment with cupping glasses: shifting along the lymphatic pathways to relieve congestion.
- CPM shoulder movement cast within the permitted range of motion: approx. six hours per day in repeated applications.

Should one of the specified signals for overload reactions arise, the treatment intensity and measures should be reviewed:

- **24 hour pain behavior**
- **Swelling/effusion**
- **Redness/overheating**
- **Reduction or stagnation of range of motion**
- **Reduction or stagnation of strength**

3.2.2 Medical training therapy

- Concomitant general training endurance on the stationary bike as well as the core and leg muscles: leg presses, leg curls and extensions, crunches.

Sensorimotor function training

- Initiation of local stabilizers (RM) within the permitted range of motion:
  - Starting in supine position: arm supported, thrust to the left/right with a bar in both hands (Fig. 3.35)

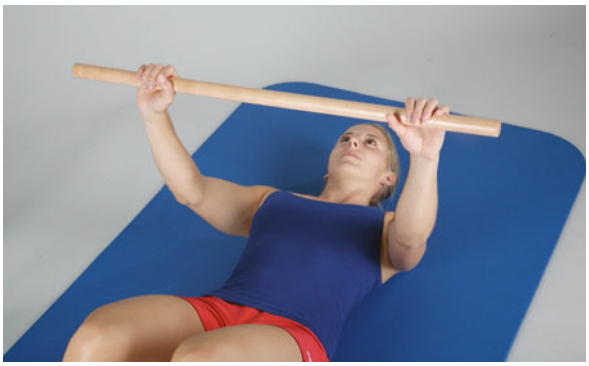


Fig. 3.35 Initiating the local stabilizers starting in supine position: arm supported, thrust to the left/right with a bar in both hands

Fig. 3.36a,b Scapular setting: Training the serratus anterior muscle with bench press plus

  - Working on everyday activities: cleaning teeth, hand-eye coordination, e.g., stacking cups
  - Grip variants on climbing rocks
  - Fine coordination without load, e.g., writing (**Cave:** LBT tenodesis!)
  - Scapular setting: repeating what was learnt from physiotherapy and muscle training. Serratus anterior muscle= bench press plus (Fig. 3.36); rhomboid muscles = angle table with upper body inclined. (**Cave:** Permitted range of movement and load!)

Fig. 3.37 Automobilization: starting in standing position to the side of the cable pulley, with traction from above to bear weight for abduction and flexion on scapular level

Fig. 3.38 Automobilization: rolling therapy ball while sitting

Fig. 3.39 Thoracic spine mobilization using the back of a chair

- Core: bar training on Posturomed, balance pad, balance board (on one leg or two legs)
- Support on the bench

Automobilization

- Starting in standing position to the side of the cable pulley: with traction from above to bear weight for abduction and flexion on scapular level (Fig. 3.37)
- Roll ball on the angle table in all directions or roll therapy ball while sitting (Fig. 3.38)
- Thoracic spine mobilization (Fig. 3.39).

Strength training

- Intramuscular activation via isometry: positions are to be held for a maximum of 8-10 seconds.
  - Starting position: seated next to Pezzi ball; the patient applies downward pressure to the ball to activate the triceps brachii muscle
  - Starting position: standing on the wall bars; grabbing the bar and pushing downwards, sideways forwards, backwards
- Strength endurance training in adduction, retroversion, 4 x 30 repetitions (reps)
- Overflow training via the contralateral side in flexion/extension direction; adduction/abduction; IR/ER; 4 x 20 reps (cable pulley training slowly concentrically and eccentrically); affected arm held in best possible position in terms of scapular setting and humeral head centering.

Isokinetics

- CPM mode (Fig. 3.40).

Set scapula and center humeral head before all exercises! During the application of CMP, the patient must control the scapular setting with an upright spinal posture and mentally follow the passive movements.

Therapeutic climbing

- Grip fixation training in different directions.
- Grip fixation training with dynamic shift in body weight while standing.

Fig. 3.40 CPM mode. During this, the patient must control the scapular setting with an upright spinal posture and mentally follow the passive movements

Fig. 3.41 Mobilization of the dorsal capsule

3.3 Phase III

Goals (in accordance with ICF)

Goals of phase III (in accordance with ICF)

- **Physiological function/bodily structure:**
  - **Improvement in functions affecting sensorimotor function**
  - **Restoration of joint mobility**
  - **Restoration of joint stability**
  - **Restoration of muscular strength/muscle endurance**
  - **Restoration of the physiological movement pattern**
- **Activities/participation:**
  - Developing an ergonomic posture in everyday life/work/sport
  - Mobility (hand-arm use, driving a vehicle)
  - Re-establishing confidence in the movement and stability of the shoulder
  - Resuming paid employment
  - Participation in the life of the community
  - Following a home training program independently

3.3.1 Physiotherapy

Patient education

- Discussing the content and goals of treatment with the patient.
- Pain management with the goal of becoming pain-free (physiological pain processing).
- Explaining and making the patient aware of his/her personal pathology.
- Providing the patient with further information regarding the level of wound healing and the limitations associated with the operation:
  - Overhead work, e.g. raising loads to high shelves etc.
- Tips to avoid poor posture.
- Ergonomic consultation for everyday life and in the workplace.
- Advice and tips for resuming sports activities.

Improving mobility

- Mobilization of the neural structures (ULNT I–III).
- Dosed intermittent stretching and movement.
- Manual mobilization of the glenohumeral joint through traction and compression, translational and angular mobilization techniques via the humeral lever.
- Mobilization of the dorsal capsule (Fig. 3.41).
- Manual mobilization of the glenohumeral joint via the scapula lever for terminal free shoulder mobility, e.g., in lateral position with the humerus initially set in different flexion and rotation positions.

Reference point of scapular setting during elevation: In maximum elevation in the glenohumeral joint, the inferior angle of the scapula sits at the level of the edge of armpit hair growth. Furthermore, the end of the movement should involve a lateral/caudal rotation of the scapula.

- Improving joint mobility through manual therapeutic measures, depending on findings. Treatment of: OAA complex, cervical spine, thoracic spine (Fig. 3.42), 1. Rib, rib joints.

An imbalance in the antagonistic pairs of a muscle group on the scapula leads to the non-physiological position of the scapula on the thorax or to scapula dyskinesia. Scapula dyskinesia is a change in the

Fig. 3.42 Improving joint mobility: treatment of the thoracic spine

Fig. 3.43 Soft tissue treatment through transverse stretches

normal position and movement of the scapula during scapulohumeral movement. It often arises in connection with injuries and discomfort in the shoulder joint. This leads to inhibition and poor coordination in the scapula-stabilizing muscles.

- **Example: In the case of hypertonic, shortened rhomboid muscles, the serratus anterior muscle cannot laterally rotate the scapula as well.**

- Soft tissue treatment
  - Muscle techniques:
    - Reciprocal inhibition: scapula pattern statically or dynamically in posterior depression
    - Strain-counterstrain
    - Muscle energy technique (MET)
    - Transverse stretches (Fig. 3.43)
    - Functional massage
  - Fascia mobilization:
    - Release technique
    - Pressure and stretching (neck and shoulder fasciae)

      Treating the stomach fascia (Fig. 3.44a), liver/spleen fascia or the diaphragm Fig. 3.44b) depending on findings.
- Increasing active movements: starting with a short lever, work out with a longer lever in different starting positions if there is sufficient stability (sitting, prone position, standing) while paying attention to scapula and core.
- Independent exercises for the patient:
  - Starting in standing or sitting position: crawling hand up the wall
  - Starting in quadrupedal position: slide with arms in maximum flexion position
  - Starting position: lateral position on the shoulder to be mobilized (this lies at a 90° flexion angle); the elbow held at a 90° flexion angle is used as a lever

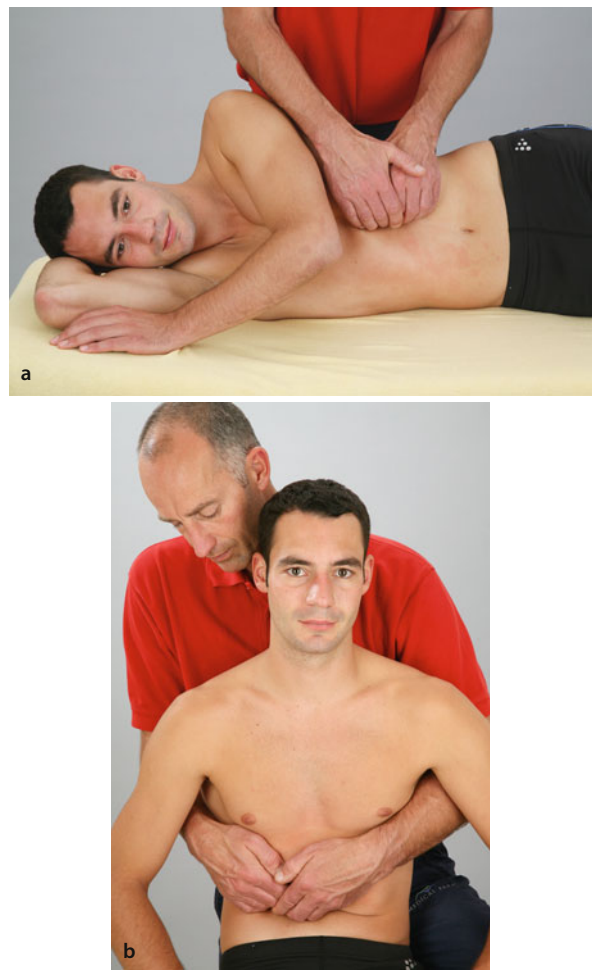


Fig. 3.44a,b Fascia mobilization: treatment **a** Of the stomach fasciae, **b** Of the diaphragm

Fig. 3.45 Independent exercise: starting in lateral position on the shoulder to be mobilized (this lies at a 90° flexion angle); the elbow held at a 90° flexion angle is used as a lever for the mobilization of the internal and external rotation with the help of the other hand

Fig. 3.46 Mobilization of the Occiput-atlas-axis complex (OAA)

for the mobilization of the internal and external rotation with the help of the other hand (Fig. 3.45)
- Starting in standing position with back to the wall: The patient holds a tennis ball in place with the scapula and actively moves the arm or assists the movement of the arm within the permitted range of motion in flexion, abduction and rotation. Begin with short levers!
- Independent mobilization of the thoracic spine via a mobilization wedge or two tennis balls placed in a sock and placed under the area to be mobilized; starting in supine or seated position:
  a. Blocking of the lumbar spine
  b. Making contact
  c. Minimal mobilization parallel to the facet level, dorso-cranially.

Pay attention to any differential diagnoses!
- **Thoracic-outlet syndrome (compression of the brachial plexus with potential involvement of the subclavian arteries and veins)**
- **Scalenus syndrome (compression in the anterior [between sternocleidomastoid muscle and scalenus anterior muscle] or posterior [between scalenus anterior and medius muscles] scalene aperture)**
- **Costoclavicular syndrome (compression between clavicle and first rib)**
- **Pectoralis minor syndrome (compression between pectoralis minor and the first rib)**

Regulation of vegetative and neuromuscular functions

- Mobilization in the orthosympathetic area of origin Th1-Th8.
- Mobilization of the occiput-atlas-axis complex (OAA) (Fig. 3.46).
- Manual therapy in the nervous area of origin of the shoulder-arm muscles C5-C8.
- Treatment of neurolymphatic and neuromuscular reflex points:
  - Supraspinatus muscle
  - Infraspinatus/teres minor muscles
  - Subscapularis muscle
  - Latissimus muscle
  - Serratus anterior muscle
  - Deltoid muscle.
- ULNT (Fig. 3.47).

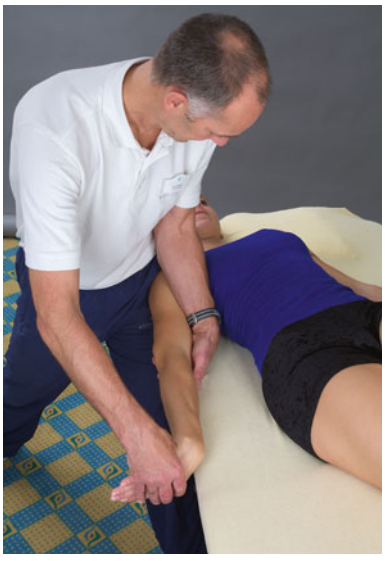


Fig. 3.47 ULNT

Improving sensorimotor function

- Target-oriented work, e.g., practicing grip function for between movement planning in central nervous system: always give the patient an object to hold in their hands or aim at while exercising.
- Open system:
  - Starting in supine position, prone position, lateral position and sitting: The patient holds his/her scapula in the optimum position, while holding or dynamically moving the arm in different abduction, internal rotation, external rotation and flexion positions. Begin without resistance and with short levers. Increase with small dumbbells and return to vertical starting position.

Goal-oriented movement enables the feed-forward innervation of the primary stabilizing muscles (stabilizers). Movement exercises are performed with a practical relation to everyday situations to help the patient to learn.

- In closed system:
  - Quadrupedal position with optimally positioned scapula (raise: one-armed)
  - Starting in prone position on the bench: push-up position (90° flexion) with hands on the floor. The less the core is supported, the harder it is to control the position: static control of serratus anterior tension (raise: one-armed)
  - Starting in quadrupedal position in accordance with Maenhout (Fig. 3.48)
  - Starting in quadrupedal position: patient supports himself/herself on instable support surfaces (Fig. 3.49)
  - Plank variants on Flowin mat (Fig. 3.50)
  - Push-up against the wall

Training in the kinetic chain in accordance with Maenhout et al. (2010):

- **Quadrupedal position and homolateral leg raised activates the serratus anterior muscle more.**
- **Raising the heterolateral leg activates the lower trapezius muscle more**

- Optimum activation of the serratus anterior muscle and ascending trapezius muscle through involvement of the upper extremities: stretching the ipsilateral leg (Fig. 3.51)

In the event of arthrolysis

- In closed system:
  - Forearm side plank under scapular control
  - Starting position: standing. Patient supports himself/herself with their arms on a Pezzi ball, which is held against the wall by the therapist. Static stabilization or even dynamically as a modified push-up exercise. Making the exercise more advanced on unstable support surfaces and with additional task of ADL exercise (holding a phone)
  - Push-up on Haramed (Fig. 3.52)
- Reactive training:
  - Dribbling against a wall
  - Throwing stabilization on the cable pulley or catching a ball, stroke movement when playing badminton (Fig. 3.53)
  - Fall training on soft mat (Fig. 3.54)
  - The therapist lets Stonies® fall, which the patient aims to catch with his/her shoulder in different angular positions. Raising with visual control, then without (Fig. 3.55).
- Inhibition of incorrect muscle recruitment due to pre-operative pathologies (e.g., pectoralis major muscle, latissimus dorsi muscle and trapezius muscle) through:
  - Visual checking via mirror
  - Biofeedback via surface EMG
  - Tactile assistance
  - Tape.

Fig. 3.48 Starting in quadrupedal position in accordance with Maenhout

Fig. 3.49 Starting in quadrupedal position: patient supports him/herself on the unstable support surfaces of the Pezzi ball and balance board

Fig. 3.50a,b Plank variants on Flowin mat

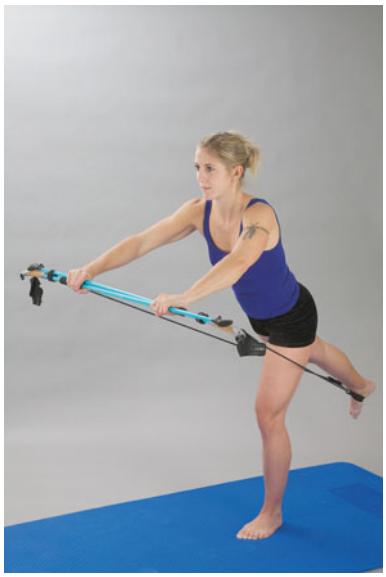


Fig. 3.51 Optimum activation of the serratus anterior muscle and ascending trapezius muscle through involvement of the upper extremities: stretching the ipsilateral leg

Fig. 3.52 Push-up on Haramed

Fig. 3.53 Stabilization of the badminton stroke movement on the cable pulley

In the case of pectoralis major transfer

- Activation of muscular function (while controlling the scapula):
  1. Static tension at scapular level in inner rotation
  2. Static tension at all levels of the shoulder joint
  3. Dynamic movement from neutral position to internal rotation to the abdomen.

In the case of latissimus dorsi transfer

- Reprogramming muscular function from IR/adduction to ER/abduction
  1. Static tension at scapular level in outer rotation
  2. Static tension at all levels of the shoulder joint
  3. Dynamic movement from external rotation to 30° internal rotation (from 8th week, free mobility).

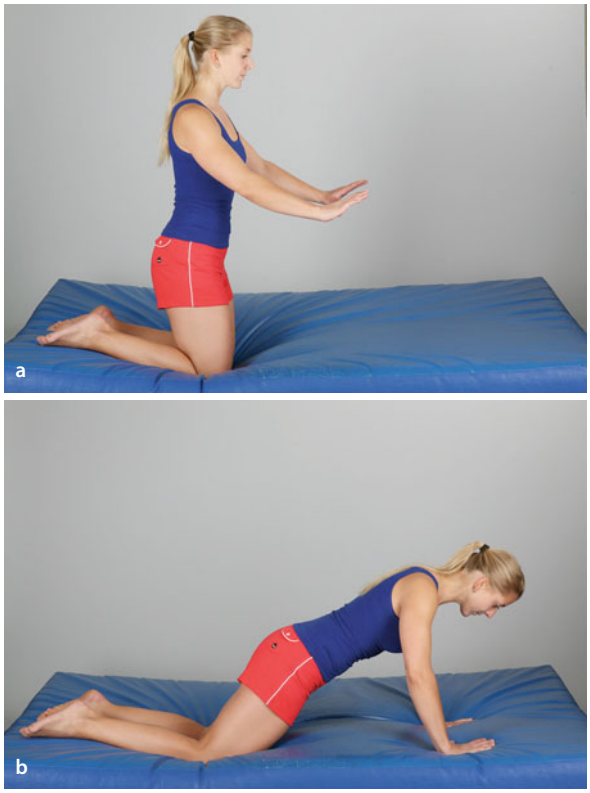


Fig. 3.54 a,b Fall training on soft mat

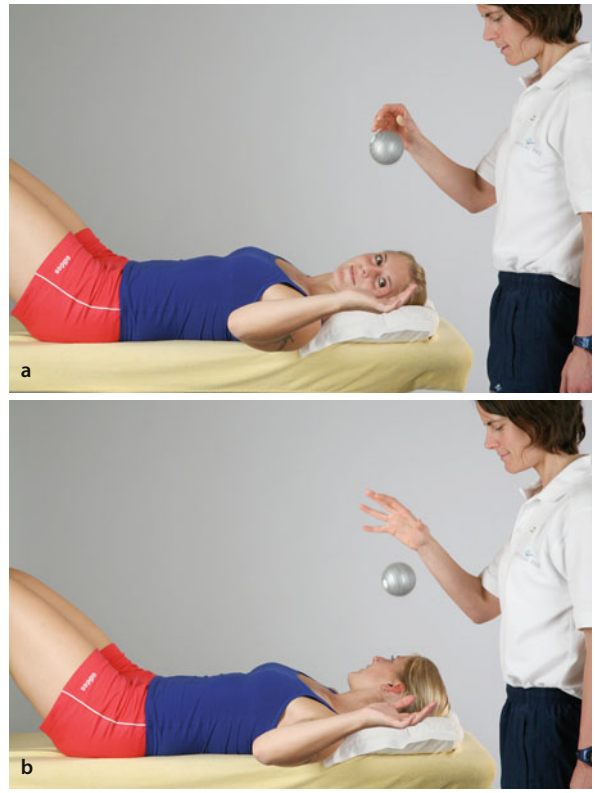


Fig. 3.55a,b The therapist lets Stonies® fall, which the patient tries to catch with his/her shoulder in different angular positions. Raising with visual control (**a**), then without (**b**)

Stabilization and strengthening

All scapula exercises require an optimum scapula position and secure humeral head centering.

- Techniques from the PNF concept:
  - Three-dimensional adjustment of arm movement with the techniques of rhythmic stabilization, stabilizing rotation, e.g., short arm pattern with non-terminal position starting from lateral position and sitting
  - Movement combinations of chopping and lifting to exercise the core muscles in the starting positions of supine position, prone position, lateral position and sitting
  - Example: starting in prone position in overhang. Lifting – eccentric dropping of the oblique abdominal muscles (Fig. 3.56).
- Training the musculature centered round the humeral head against gravity and against proportioned resistance (Fig. 3.57).
  - Push-ups
  - Side plank reformer (Fig. 3.58)
  - Redcord®.
- Stabilization of the deep neck muscles while activating the arm at the same time, e.g., in supine position/while sitting.
- Developing dynamic control: This requires the patient to have sufficient mobility in the shoulder and to be able to control the scapula well statically.
- Strengthening the shoulder muscles, concentrically and eccentrically in alternation, along the entire functional chains with core involvement.
- Strengthening the scapular stabilizers: trapezius muscle, rhomboid muscles, latissimus dorsi muscle, serratus anterior muscle, levator scapulae muscle:
  - Starting in prone position: In the arms extended against the body, bring the shoulder joint into retraction/depression, with additional weights
  - Starting in prone position: With arms elevated at scapula level, breastbone maintains contact with the ground; external rotation while holding serratus anterior tension (Fig. 3.59)

  Note: limited activity in the medial and lower trapezius muscle in patients with impingement; limited activity in the serratus anterior muscle in

Fig. 3.56a,b Starting in prone position in overhang. **a** Lifting – eccentric dropping of the oblique abdominal muscles, **b** As independent exercise with Theraband

patients with impingement in accordance with Cools et al. (2007)

- The following exercises have a good relationship between the activity of the upper/medial trapezius muscle and between the upper/lower trapezius muscle:
  Starting in lateral position: horizontal flexion (Fig. 3.60)
  Starting in lateral position: external rotation
  Starting in prone position: horizontal abduction and external rotation (Fig. 3.61)
  Starting in prone position: prone retroflexion (Fig. 3.62)
  Pilates
  Cable pulley (Fig. 3.63)
  Bodyblade, also on unstable support surfaces, e.g., Powerplate® (Fig. 3.64)
  Training the scapulothoracic muscles and the rotator cuff with involvement of the torso's core muscles (Fig. 3.65).

Weakness in the latissimus dorsi muscle favors the shortening of the upper part of the trapezius.

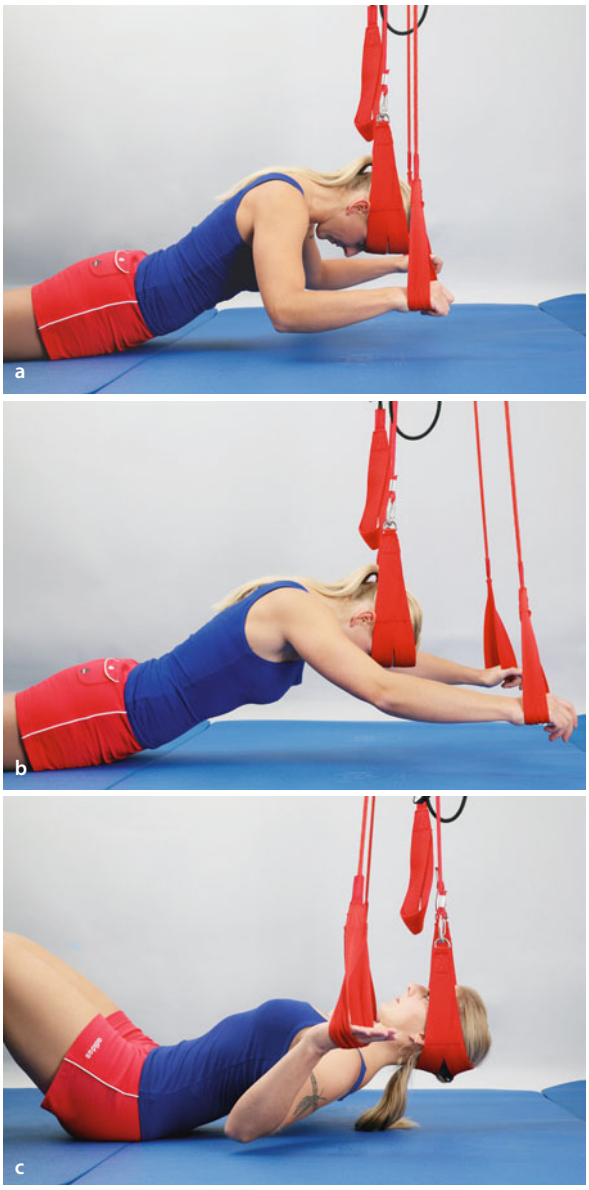


Fig. 3.57a–c Training the musculature centered round the humeral head against gravity and against proportioned resistance

Fig. 3.58 Side plank reformer

Fig. 3.59 Starting in prone position: with arms elevated at scapula level, breastbone retains contact with the ground; external rotation while holding serratus anterior tension

Fig. 3.60 Starting in lateral position: horizontal flexion

Fig. 3.61 Starting in prone position: horizontal abduction and external rotation

Fig. 3.62 Starting in prone position: prone retroflexion

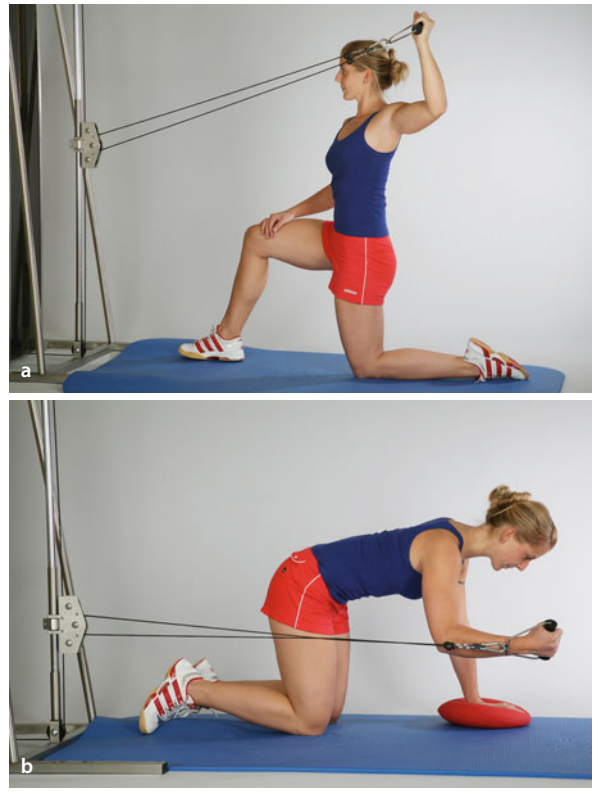


Fig. 3.63a,b Strengthening the scapula stabilizers using the cable pulley

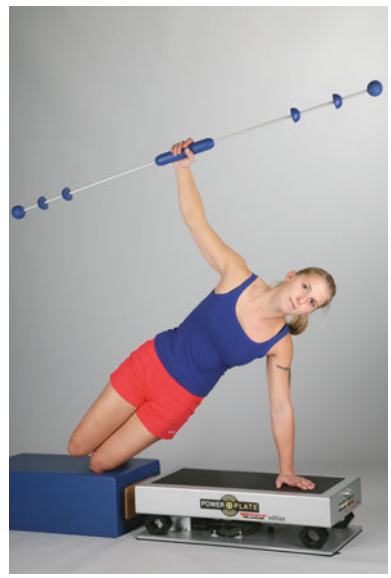


Fig. 3.64 Bodyblade, also on unstable support surfaces, e.g. Powerplate®

Fig. 3.65a–d Training the scapulothoracic muscles and the rotator cuff with involvement of the torso's core muscles; "the painter" exercise

- Training scapulothoracic rhythm in open and closed system:
  - Centering in the eccentric phase using cable pulley (Fig. 3.66).

Endoprostheses

- Increasing active movements with a short lever in various everyday starting positions (sitting and standing) while paying attention to scapula and core with target-based movements.
- Independent exercise:
  Starting position: standing with back to the wall and holds a tennis ball steady using the scapula. At the same time, depending on the permitted degree of activity, actively moves the arm or assists the movement of the arm within the permitted range of motion in flexion, abduction and rotation.
- Starting position: When sitting in front of the Pezzi ball or in prone position on the bench in overhang, the patient supports him/herself against the Pezzi ball. The patient then moves into flexion or works statically against the therapist's resistance with a well-stabilized scapula and centered shoulder.
- Starting in seated position: The lower arms are placed on a ball cushion, and the patient works contralaterally

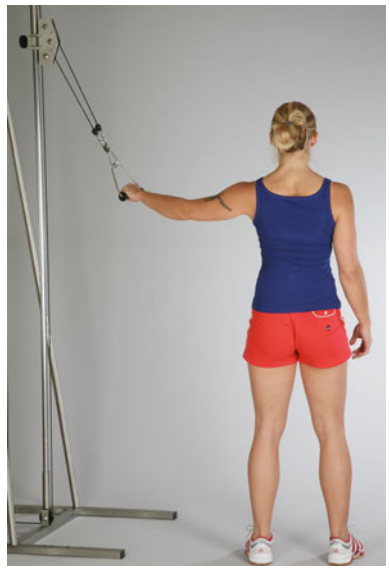


Fig. 3.66 Training scapulothoracic rhythm in open and closed system: centering in the eccentric phase using cable pulley

Fig. 3.68 Scaption raises (elevation to glenoid level) with weight

Fig. 3.67 Starting in seated position: ER with elbows bent at 90° from 80° IR to neutral position against gravity force

with a Vitality® band in PNF patterns (or with dumbbells).

- Training the musculature centered round the humeral head against gravity and against proportioned resistance within the permitted range of motion (e.g. starting in lateral position on side that did not undergo surgery; starting in sitting position: ER with elbows bent at 90° from 80° IR to neutral position against gravity force (muscle function test value 2–3, Fig. 3.67).
  - Strengthening the serratus anterior muscle in open system and in plank
  - Scaption raises (elevation to glenoid level) with/without weight (Fig. 3.68)
  - Supine position/standing: A Vitality® band is wound around both hands in neutral position (with elbow joint flexed at 90°). Tense hands in dext and elevate the arms symmetrically in external rotation. Forearms remain parallel to each other and are vertical along the entire path of movement (Fig. 3.69)
  - Standing in front of the wall: The patient holds a ball in both hands in external rotation position centered in front of the body. The forearms should remain as parallel to each other as possible while the ball is rolled upwards on the wall (Fig. 3.70).
- Strengthening the rotator cuff and the muscles caudalizing the humeral head.

Physical measures

- Massage: removal of adhesives from the scapulothoracic joint.
- Treating the head zones of the stomach and liver: Localization left/right in the subclavian groove and above the acromion.
- Cryokinetics.
- Cool packs or Cryocuff as gentle cooling.
- Manual lymph drainage (MLD).
- Connective tissue massage.
- Foot reflexology massage.
- Acupuncture massage.
- Massage.
- Electrotherapy: high voltage (no interaction with implant).
- Hot rolls, e.g., locally applied to detonize hypertonic muscles or for reflex therapy in the sympathetic supply area of the upper extremity.
- Fango.

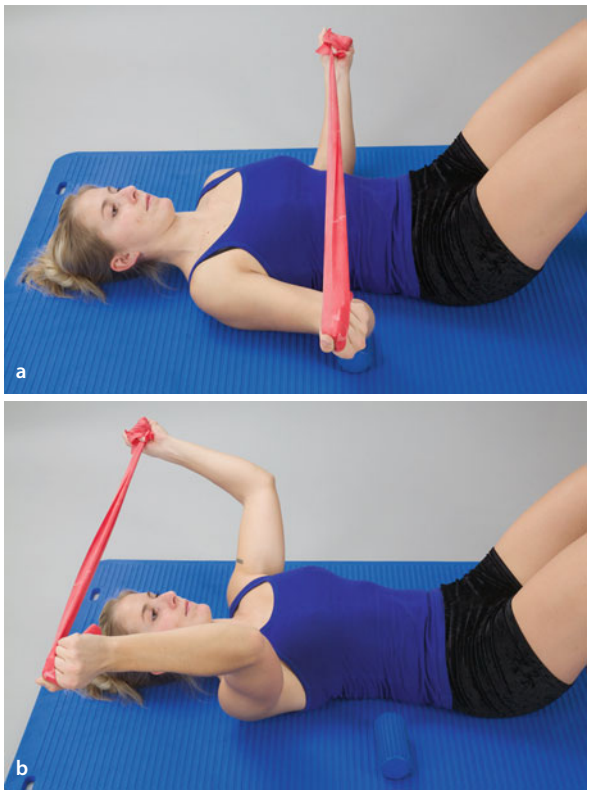


Fig. 3.69a,b Starting in supine position. **a** A Vitality® band is wound around both hands in neutral position (with elbow joint flexed at 90°). **b** Tense hands in dext and elevate the arms symmetrically in external rotation. Forearms remain parallel to each other and are vertical along the entire path of movement

3.3.2 Medical training therapy

- General accompanying training of endurance as well as the core and leg muscles.

Sensorimotor function training

- Controlling the local stabilizers within the permitted range of motion:
  - IR/ER within the permitted range of motion using the cable pulley with dumbbell (weight 200g – 500g).
- Working on planks, hanging, pulling, pushing:
  - Support in quadrupedal position, transferring weight between hands (Fig. 3.71)
  - Reverse push-up on the wall bars
  - Push-up on the wall bars
  - Weight-supported pull-ups.
- Core: standing on balance board and additionally compressing a roll (Fig. 3.72).
- Fine coordination with load or speed (e.g., juggling, balancing a bar etc.).
- Unstable environments (e.g., support on Pezzi ball, forearm plank on Aerostep) (Fig. 3.73).
- Developing precision control (ability to control movements precisely), e.g., gripping bars at various highs/distances, different weights.

Automobilization

- Cable pulley laterally with traction from above, with weight reduction abduction/flexion.
- Thoracic spine mobilization.

Fig. 3.70a–c Standing in front of the wall: The patient holds a ball in both hands in external rotation position centered in front of the body. The forearms should remain as parallel to each other as possible while the ball is rolled upwards on the wall

Fig. 3.71a–c Support in kneel position, transferring weight between hands

Fig. 3.72 Standing on balance board and additionally compressing a roll

Strength training

- Strength endurance training of the local stabilizers during warm-up: IR/AR (Fig. 3.74).

Practical tip

Serratus activity
Training the following exercises:
- Push-up plus
- Serratus anterior punch
- Dynamic hug
- Scaption

- Training the scapular fixators: bench presses (Fig. 3.75) bench press plus.
- Training subscapularis muscle: functionally dividing the muscle into an upper part and a lower part. Training for both parts:
  - Push-up plus (push-up movement with protraction of the shoulder girdle at the end of the movement) (Fig. 3.76)

A weakened serratus anterior muscle reduces scapula rotation and protraction. The humeral head can translate anterorally/superiorally and thereby lead to a secondary impingement.

- Plank: functional series from easy to hard (beginning of phase III to end of phase III/IV) (Fig. 3.77).
  - Diagonal exercise (stepping forward with back to the cable pulley)
    Starting position: shoulder joint 90° abduction + ER, elbow joint slight flexion

Fig. 3.73a–d Unstable environments. **a** Plank on Pezzi ball, supported core, **b** Quadrupedal position on unstable support surfaces, **c,d** Full body training

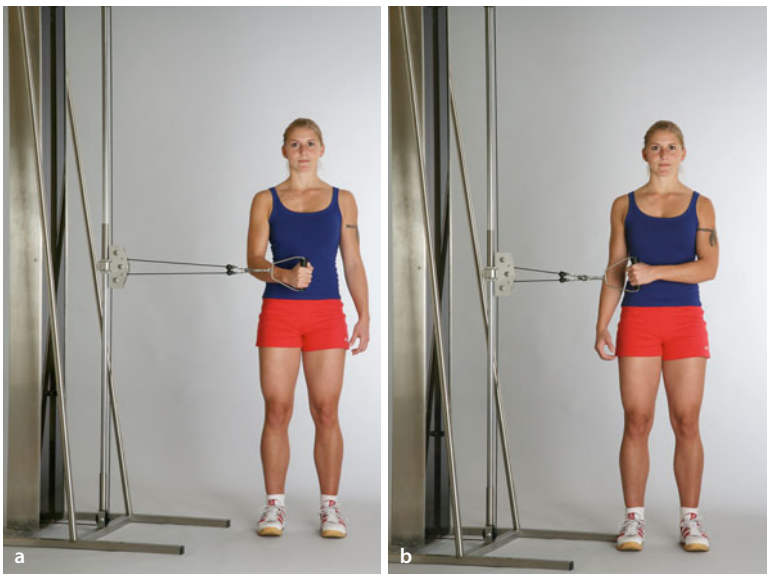


Fig. 3.74a,b Strength endurance training of the local stabilizers during warm-up. **a** IR, **b** ER.

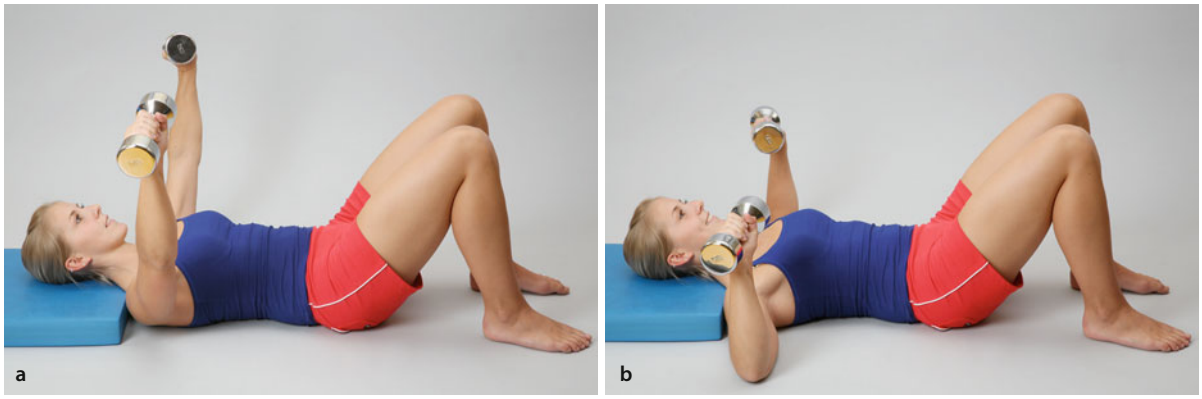


Fig. 3.75a,b Training scapular fixators: Bench presses

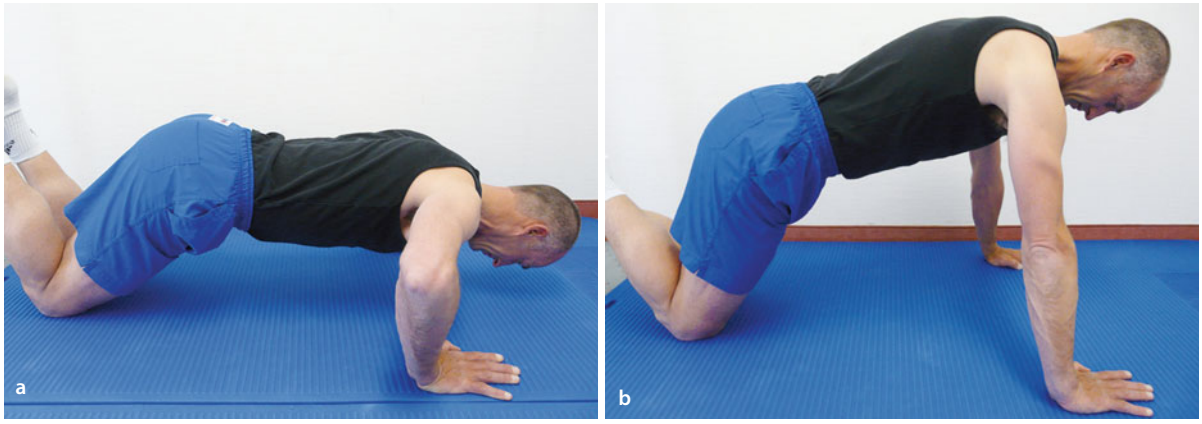


Fig. 3.76a,b Push-up plus: push-up movement with protraction of the shoulder girdle at the end of the movement

Finish position: shoulder joint adduction/IR
Traction direction: until handle at height of contralateral SIAS
- Training for upper part:
  - Cable pulley: the greater the angle of abduction, the higher the activation
- Training for lower part:
  - Cable pulley: IR with 45° abduction

- Muscle building training of the mobilizers: latissimus dorsi muscle, deltoid muscle, trapezius muscle, triceps muscle, pectoralis muscle (bench press, push-up, rowing Fig. 3.78, dips, latissimus traction machine, triceps, biceps (**Cave:** LBTtenodesis!)
- Hypertrophy training within a medium range of motion (in completely pain-free range): approx. 4-6 weeks, 6 x 15 reps or in the form of pyramid training: 18/15/12/12/15/18.
- Intramuscular coordination training: approx. 4–6 weeks × 3–5 reps, average range of motion.
- Hypertrophy training: 6 x 15 reps or in the form of pyramid training: 18/15/12/12/15/18; overflow via the contralateral side (Fig. 3.79).

Therapeutic climbing

- Grip changing training in different directions (precisely hold in place 3-4 different handles within a short space of time with a specified direction of motion, e.g., only upwards/downwards).
- Grip fixation training with dynamic shift in body weight against the wall: hold two handles in place, with the legs shifting the position with a stable shoulder position.
- Grip fixation training in different directions in the negative wall area (Fig. 3.80).

3.4 Phase IV

The objective of training in phase IV lies in the patient's ability to resume sporting activities. The sports-therapeutic content of rehabilitation phase IV following shoulder joint operations is summarized for the entire upper extremity in ▶ Section 5.4.

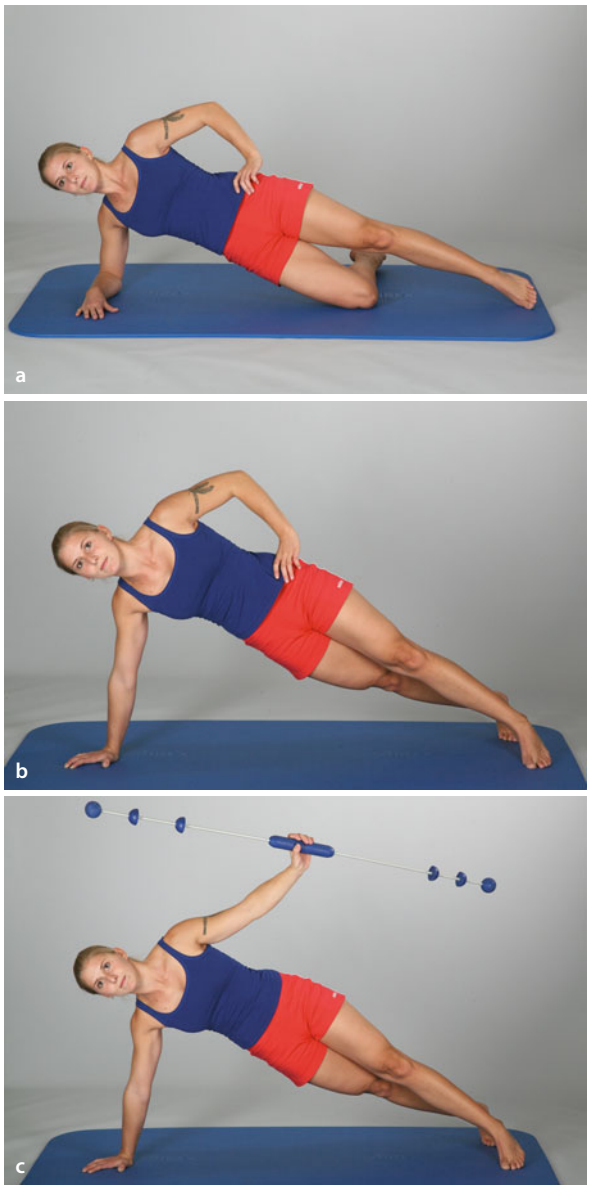


Fig. 3.77a–c Plank: Functional series from easy to hard (beginning of phase III to end of phase III/IV)

Fig. 3.78 Muscle building training of the mobilizers: latissimus dorsi muscle, deltoid muscle, trapezius muscle, triceps muscle through rowing

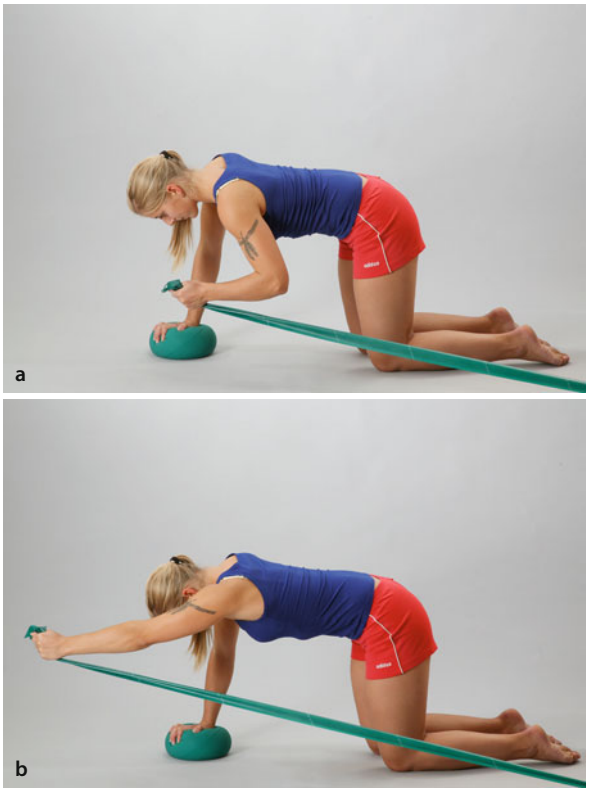


Fig. 3.79a,b Hypertrophy training: overflow via the contralateral side

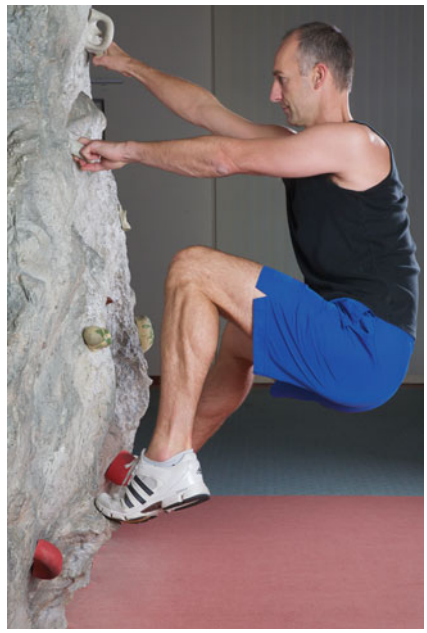


Fig. 3.80 Grip fixation training

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Elbow: Surgical procedure/ aftercare

Andreas B. Imhoff, Knut Beitzel, Knut Stamer, Elke Klein

A. Imhoff et al. (Eds.), *Rehabilitation in Orthopedic Surgery*,
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4.1 Stabilization

4.1.1 Capsule/ligament reconstruction in the event of elbow joint instability

Indication

- Traumatic elbow dislocation.
- Recurring dislocation.

Approach

- Checking circulation, motor skills, sensitivity and radiological imaging.
- Closed reposition, stability and X-ray tests.
- In the case of joint instability or fracture or vessel-nerve injury, there exists an indication for surgery.

Surgical method

- Medial or lateral (Kocher) skin incision (depending on pathology).
- Fracture reduction and fixation (where necessary).
- Tendon suture or tendon resuspension, potentially capsular resuspension in the event of acute instability (potentially use of suture anchor system).
- Potentially ligament plastic surgery through tendon transplant (e.g., triceps muscle or palmaris longus muscle) or in the case of chronic instability.
- Fixation of the transplant at the anatomical resection site on the medial or lateral epicondylus.
- Wound closure layer by layer.

Aftercare

An overview of aftercare can be found in Table 4.1 and Table 4.2.

4.2 Cartilage surgery

4.2.1 OATS elbow

Indication

- Focal osteochondral lesions.
- Osteonecrosis (e.g., panner disease).

Surgical method

- Potentially arthroscopy via standard portals to assess pathology.

Table 4.1 Elbow dislocation (conservative). Plaster cast (90°) for one week (exercises out of the cast permitted)

Phase	Range of motion and permitted load	
I	from 1st day post-op:	Free range of movement No load for six weeks
II	from approx. 7th week post-op:	Jogging/walking/swimming/cycling
III	approx. 3 months post-op:	Sport-specific training
IV	approx. 4 months post-op:	Contact and high-risk sports

Table 4.2 Capsule/ligament repair following elbow dislocation. Plaster cast for 4-5 days, switch to EpicoROM cast from the fifth day post-op (for at least six weeks in total)

Phase	Range of motion and permitted load	
I	Weeks 1-2:	Ex/fl: 0–20–90 degrees, no pro/sup
	weeks 3-4:	Ex/fl: 0–10–110: Pro/sup free
	weeks 5–6:	Ex/fl: free mobility within the EpicoROM splint
	1st to 6th week post-op:	Physiotherapy: free passive range of motion depending on pain situation.
II	from approx. 7th week post-op:	Jogging/walking
III	approx. 3 months post-op:	Swimming/cycling
IV	approx. 6 months post-op:	Sport-specific training
	approx. 9 months post-op:	Contact and high-risk sports

Table 4.3 OATS elbow. Plaster cast for between four and five days, exercising out of the cast from first day post-op; switch to EpicoROM cast from the fifth day post-op (for a total of six weeks)

Phase	Range of motion and permitted load	
		No load (especially axial support load) for six weeks Free pronation and supination movements
I	1st to 2nd week post-op:	Ex/fl: 0–10–110 degrees, no pro/sup
II	3rd to 6th week post-op:	Active assisted flexion/extension: free
III	from 7th week post-op:	Free active range of motion (jogging/walking)
	approx. 2 months post-op:	Swimming
IV	approx. 3 months post-op:	Cycling, sport-specific training
	approx. 6 months post-op:	Contact and high-risk sports

- Medial or lateral access depending on the location of the lesion.
- Punching the lesion with the extraction cylinder and then determining the size of the transplant.
- Removing the correlating cylinder dispenser via an approx. 3cm long incision laterally to the patella from the lateral femur condyles (trochlea).
- Bringing the cylinder dispenser in the press-fit technique under height and location control.
- Wound closure layer by layer.

Aftercare

Table 4.3 provides an overview of aftercare.

4.3 Endoprosthesis

4.3.1 Endoprosthesis of the elbow joint

Indication

- Advanced primary and secondary arthroses should conservative measures fail.
- Rheumatoid arthritis.
- Improperly healed fractures.

Surgical method

- Dorsal skin incision of approx. 12cm with radial curve around the peak of the olecranon.
- Preparation of the ulnar nerve and neurolysis, splitting the triceps tendon and bony raising of the tendon.
- Resection of the bone blocks through resection template and adjustment of the prosthesis (Fig. 4.1).
- Sample reposition (coupled or uncoupled) and monitoring of the range of motion.

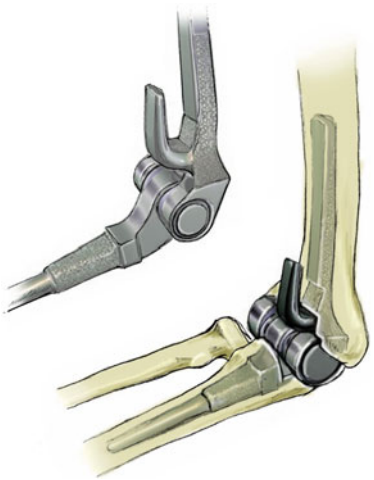

Fig. 4.1 Connected total endoprosthesis elbow

- Fixing the components with cement.
- Wound closure layer by layer.

Aftercare

Table 4.4 provides an overview of aftercare.

4.4 Arthrolysis

4.4.1 Arthrolysis of the elbow joint

Indication

- Conservatively non-treatable advanced restriction of the range of motion.

Table 4.4 Elbow endoprosthesis. Plaster cast for 4-5 days; switch to EpicoROM cast from the fifth day post-op (for at least six weeks in total)

Phase	Range of motion and permitted load	
I	1st to 2nd week post-op:	Passive flexion/extension: free
II	3rd to 6th week post-op:	Active assisted flexion/extension: free
III	from 7th week post-op:	Free active range of motion
IV		Jogging/walking/swimming without arm strokes (potentially with use of aids) **Cave:** A further increase in load requires a specific therapy decision/contact and high-risk sports not recommended!

Table 4.5 Arthrolysis of the elbow joint. Potential use of a Quengel orthosis or alternating position in plaster frame

Phase	Range of motion and permitted load	
I II	1st to 4th weeks post-op:	Intensive movement exercise starting immediately No restriction of movement, intensive terminal passive exercise (multiple times per day), instructions for independent exercise
III IV	from approx. 4th week post-op:	Jogging/walking, cycling, swimming, sport-specific training, contact and high-risk sports

Surgical method

- Insertion of an ulnar and radial arthroscopic portal.
- Electrothermic loosening of the parts of the capsule, removal of potential osteophyte cultivations and removal of free joint bodies while controlling the mobility achieved as well as paying particular attention to the nerve processes.
- Wound closure layer by layer.

Aftercare

Table 4.5 provides an overview of aftercare.

References

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Elbow: Rehabilitation

Andreas B. Imhoff, Knut Beitzel, Knut Stamer, Elke Klein

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5.1 Phase I

Goals (in accordance with ICF)

Goals of phase I (in accordance with ICF)

- **Physiological function/bodily structure:**
  - **Pain relief**
  - **Promoting resorption**
  - **Regulation of impaired vegetative and neuromuscular functions**
  - **Preventing functional and structural damage**
  - **Retaining/improving joint mobility**
  - Improving joint stability
  - Improvement in functions affecting sensorimotor function
  - Learning scapular setting
- **Activities/participation:**
  - Carrying out daily routine with pressure relieved on the arm that underwent surgery
  - Exercising the muscle pump independently
  - Promoting mobility (maintaining and changing body position, walking and moving forwards)
  - Breaking down barriers that impede participation (anxiety)

5.1.1 Physiotherapy

Patient education

- Discussing the content and goals of treatment with the patient.
- Position: In order to promote venous return, the arm should be held in a position above heart height without pressure being applied; the hand should be higher than the elbow, which in turn should be higher than the shoulder.
  - **Arthrolysis:** The arm is held in maximum flexion and extension positions alternatively in a Quengel cast. Changing position after two hours, ideally more frequently, provided that the patient can tolerate this. Accompanying administration of analgesics for mobilization and support.
- Patient information: The patient should be informed about the operation and its associated limitations in order to be able to support tissue healing through his/her behavior.

The following are forbidden in phase one following elbow surgery:

- **Raising and carrying weights**
- **Supporting yourself on your hand or elbow**
- **Rapid, abrupt movements.**

- In the case of arthrolyses, patient compliance is of particular importance. The patient also needs to mobilize, stretch and support the joint independently, in order to prevent stiffness from redeveloping.

The following limitations are to be taken into consideration in order to secure the result of the operation:

- **Limiting valgus loads: no shoulder adduction or internal rotation against resistance, planks in ER and supination**
- **Limiting valgus loads: no shoulder abduction or external rotation against resistance, planks in IR and press.**

Prophylaxis

- Early mobilization from bed.
- Instruction on SMI trainer, deep breathing techniques such as nose stenosis, "sniffing" inhalation, breathing control.
- Active movement in the ankle joints.
  Please note that the movements are performed terminally once per second in order to significantly increase flow velocity.
- Active punching or, under free elbow mobility, actively moving the elbow joint within all degrees of freedom. (The exercises should be performed regularly, ideally hourly, independently by the patient).
- Walking.

Promoting resorption

- Activating the muscle pump by firmly opening and closing the fist.
- Pump exercise with softball.
- Elevation.
- Gently stroking the fingers towards the shoulder.
- Manual lymph drainage.
- Isometry.
- Observing the venous outflow routes and potentially treatment of bottlenecks: detonization of the scaleni and pectoralis minor muscles, mobilization of the first rib (Fig. 5.1), clavicle.

Improving mobility

- Retaining the mobility of the neighboring joints: hand, shoulder, distal radioulnar joint, cervical spine, thoracic spine
- Soft tissue treatment:
  - Treatment of potential trigger points with techniques in accordance with Simons/Travel
  - Muscles with MET techniques, integrated neuromuscular inhibition technique (INIT), strain counterstrain (SCS), functional massage, recipro-

Fig. 5.1 Controlling venous outflow routes, mobilization of the 1st rib

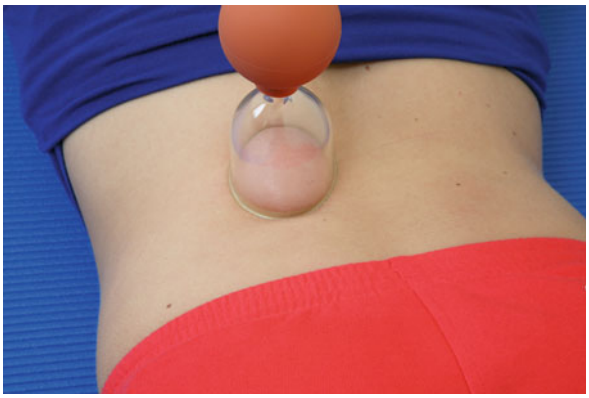

Fig. 5.2 Cupping glass massage

cal inhibition, relaxation techniques from the PNF concept:
- Biceps brachii muscle
- Triceps brachii muscle
- Coracobrachialis muscle
- Brachialis muscle
- Extensor and flexor group of the lower arm
- Supinators and pronators of the elbow
- Pectoralis minor and major muscles.

Practical tip

For **long-term treatment**, apply alternating ice compresses for approx. 8-10 minutes to the muscles to be relaxed.
Cave: Never apply ice directly to the skin or to cold tissue, as there is a risk of frostbite.

- Passive or actively assisted movement of the elbow joint and the lower arm joint within a pain-free range following the procedure.

Frequent Complications

The following complications frequently arise in connection with injuries in the elbow area:
- Myositis ossificans
- Arthrogenic contracture
- Ulnar nerve affections

In the event of arthrolysis

- Targeted manual joint mobilization techniques to improve the elasticity of the joint capsule: MT (Kaltenborn) level 3 (against resistance!), Maitland 4

Regulation of vegetative and neuromuscular functions

- Manual therapy in the nervous area of origin of the shoulder-arm muscles (C5-C8).
- Electrotherapy.
- Hot rolls.
- Cupping glass massage (Fig. 5.2).
- Treatment of potential trigger points in accordance with Simons/Travel or the INIT technique.
- Treatment of the orthosympathetic origin (Th1-Th5) due to their influence on the arterial supply to the arm.

Improving sensorimotor function

- Minimal traction and compression level 1 from MT as afferent sensomotory input to stimulate mechanoreceptors.
- Isometry (Fig. 5.3).
- To integrate the impaired muscles, activation along the kinetic chain through Vojta, E-technique, PNF. Example: Building pressure from the distal direction (in PNF chains with static tensioning of the distal components in line with the arm pattern against guided contact, e.g. through a technique of rhythmic stabilization).

Stabilization and strengthening

- Exercises with the Vitality® band on the extremity not affected, making sure to observe correct posture.
- Isometry in the matrix load range (level I manual therapy within the pain-free range).
- Core stabilization.

Physical measures

- Massage of the shoulder-neck muscles.
- Manual lymph drainage.
- Cryokinetics.

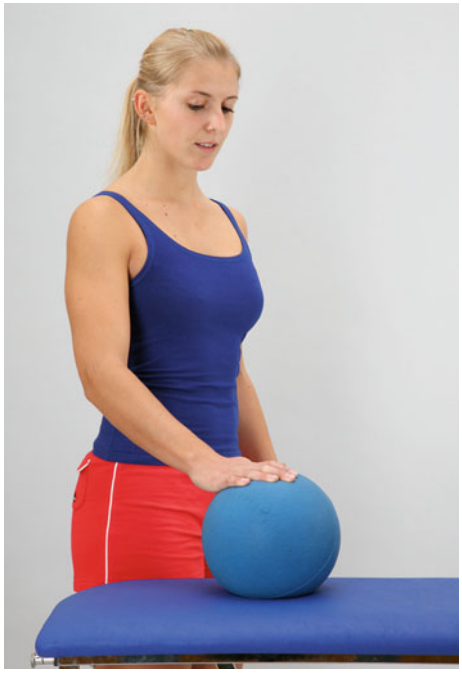

Fig. 5.3 Improving sensorimotor function through isometric tensioning

- Cool packs or Cryocuff as gentle cooling.
- Use of the CPM splint.

5.2 Phase II

Goals (in accordance with ICF)

Goals of phase II (in accordance with ICF)

- **Physiological function/bodily structure:**
  - **Pain relief**
  - **Promoting resorption**
  - **Improving joint mobility**
  - **Improving sensorimotor function**
  - Regulation of impaired vegetative and neuromuscular functions
  - Improving joint stability
- **Activities/participation:**
  - Carrying out daily routine with pressure relieved on the arm that underwent surgery
  - Exercising the muscle pump independently
  - Promoting mobility (maintaining and changing body position, tips for hand-arm usage)
  - Breaking down barriers that impede participation (anxiety)

5.2.1 Physiotherapy

Patient education

- Discussing the content and goals of treatment with the patient.
- Patient information: The patient should be informed about the operation and its associated limitations in order to be able to promote tissue healing through his/her behavior:
  - Raising and carrying weights
  - Pushing against resistance
  - Supporting yourself on your hand or elbow
  - Rapid, abrupt movements
  - Medial instability: no valgus stress
  - Lateral instability: no valgus stress.
- Should increased pain symptoms arise such as redness, swelling and loss of function/sensitivity, seek follow-up from the surgeon immediately.

In the case of arthrolysis, patient compliance in terms of independent mobilization, stretching and support is of particular importance.

Promoting resorption

- Activating the muscle pump by:
  - Firmly opening and closing the fist
  - Kneading a softball.
- Elevation.
- Manual lymph drainage.
- Isometry.
- Passive or actively assisted movement of the elbow joint and the wrist.
- Kneading a softball.
- Observing the venous outflow routes and potentially treatment of bottlenecks: detonization of the scaleni and pectoralis minor muscles, mobilization of the first rib, clavicle.

Improving mobility

- Mobilization of the elbow joint within the approved range of motion.
- Retaining the mobility of the neighboring joints: hand, shoulder, shoulder girdle, cervical spine
- Manual therapy in the nervous area of origin C5-C8.
- Soft tissue treatment:
  - Treatment of anterior and medial neck fasciae, upper arm and forearm fasciae (Fig. 5.4), shoulder fasciae
  - Hypertonia, shortened muscles (Biceps brachii muscle, triceps brachii muscle, coracobrachialis muscle, brachialis muscle, extensor and flexor group of the forearm, supinators

Fig. 5.4 Treatment of the upper arm and forearm fasciae

and pronators of the elbow, pectoralis minor and major muscles) through:
- Functional massage
- MET
- Strain-counterstrain
- Integrated neuromuscular inhibition technique (INIT)
- Relaxation techniques from the PNF concept: Hold relax (purely static muscle tension with subsequent relaxation) and reciprocal inhibition (antagonist inhibition).

- Use of the CPM splint.
- Passive or actively assisted movement of the elbow joint and the lower arm joint within a pain-free range following the procedure (Fig. 5.5).
- Arthrokinetic mobilization (MT in rest position as well as while moving).
- Improving neural mobility via slider techniques within the distal or proximal arm area (hand or shoulder/cervical spine).

In the event of arthrolysis

- Targeted manual joint mobilization techniques to improve the elasticity of the joint capsule: MT level 3 (against resistance!), Maitland level 4.
- Arthrokinetic mobilization with MT in rest position as well as while moving, with and without compression.
- Retaining the mobility of the neighboring joints.
- Passive or actively assisted movement of the elbow joint and the wrist.

Regulation of vegetative and neuromuscular functions

- Treatment in the orthosympathetic and parasympathetic areas of origin (Th1-Th8), OAA complex:
  - Manual therapy
  - Hot rolls

Fig. 5.5a,b Actively assisted movement of the elbow joint and the lower arm joint within a painless range following the procedure

  - Electrotherapy (high voltage for endoprostheses!)
  - Cupping glass massage.
- Treatment for functional disorders in the key areas:
  - OAA complex (Occiput-atlas-axis)
  - Cervicothoracic transition
  - Thoracic (1-5), costovertebral joints (1-5).
- Treatment of potential trigger points with techniques in accordance with Simons/Travel or INIT.
- Improving neural mobility via local or slider techniques within the distal or proximal arm area.

Improving sensorimotor function

- Minimal traction and compression alternately as afferent sensomotory input.
- Exercising in closed system for coactivation.
- Perceiving sense of joint position (replication/placing/ideokinesis technique).
- Improving depth perception: Use of an inclinometer, laser pointer or use of isokinetics in angle reproduction.
- Perceiving joint position through the replication/placing technique.
- Improvement intramuscular and intermuscular coordination:

Fig. 5.6 Switching between concentric and eccentric: in combination with the gripping function, put a spoon in the patient's hard and exercise

- Switching between concentric and eccentric: in combination with the gripping function, put a spoon in the patient's hand and exercise (Fig. 5.6)
- Elbow flexion and extension via dynamic rotation with guided contact
- Where turning movements are permitted, PNF: timing for emphasis for the weaker muscles. Example: arm pattern of flexion-adduction-ER and emphasis on supination for intramuscular and intermuscular coordination.

- Improving depth perception:
  Use of an inclinometer, laser pointer or use of isokinetics in angle reproduction.
- Awareness exercises and movement training for the spiral screw connection using:
  - Spiral flexion
    Starting position: supine position, arm lies next to the body, shoulder joint IR, elbow joint 90° lexion+supination
    Finish position: Shoulder joint 90° flexion+ER, elbow joint extension+pronation
  - Spiral extension (combination of shoulder joint tension in flexion, abduction, external rotation with simultaneous pronation and extension in elbow joint) (Fig. 5.7)
    Starting position: Sitting, palms resting on the thigh (extension+pronation)
    Finish position: Palms in front of face (flexion+supination).

Fig. 5.7 Spiral extension: combination of shoulder joint tension in flexion, abduction, external rotation with simultaneous pronation and extension in elbow joint

Fig. 5.8 PNF: Arm with rhythmic stabilization technique

- Elbow flexion and extension through dynamic rotation with guided contact within the pain-free range. PNF: arm with rhythmic stabilization technique (Fig. 5.8).

Stabilization and strengthening

- Building pressure from the distal direction – in PNF chains with static tensioning of the distal components in line with the arm pattern against guided contact through a technique of rhythmic stabilization.
- Dynamic rotation from the PNF concept should the activity of the biceps brachii and triceps brachii muscles be allowed.
- Stabilization of the deep neck flexors, e.g. with stabilizer (▶ Section 16.2.1).
- Strengthening the scapular fixators and the rotator cuff.

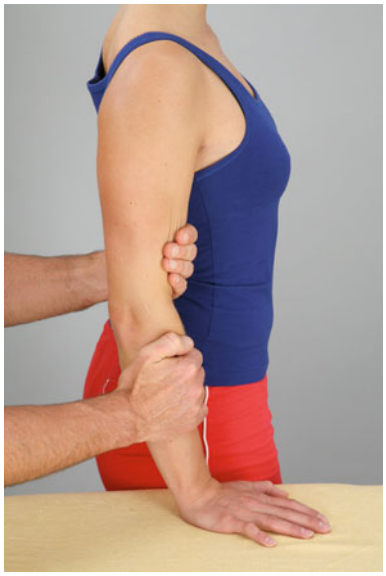

Fig. 5.9 Closed system exercise (without bearing weight): static exertion under rotator resistance on proximal forearm or distal upper arm

Cave: In ER, varus load on the elbows while controlling weight on the forearm; valgus load in IR.

- Initiating support and gripping function on climbing rocks.
- Closed system exercise (without bearing weight): Static exertion under rotator resistance on proximal forearm or distal upper arm (Fig. 5.9).
- Stabilization on unstable support surface.
- Open system work-out: Hand pattern, dumbbells for wrist flexors and extensors(Fig. 5.11).

Fig. 5.10 Stabilization on unstable support surface

Avoid longer static forces on the cartilage!

- Mini dumbbells for wrist flexors and extensors as well as radial and ulnar abductors (Fig. 5.12).

In the event of arthrolysis

- Strengthening the core muscles (Fig. 5.13).

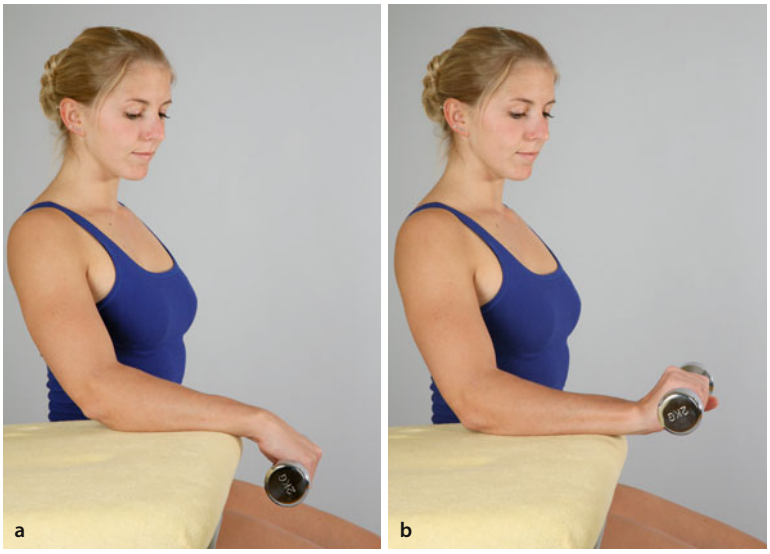

Fig. 5.11a,b Open system work-out: hand pattern, dumbbells for wrist flexors (**a**) and extensors (**b**)

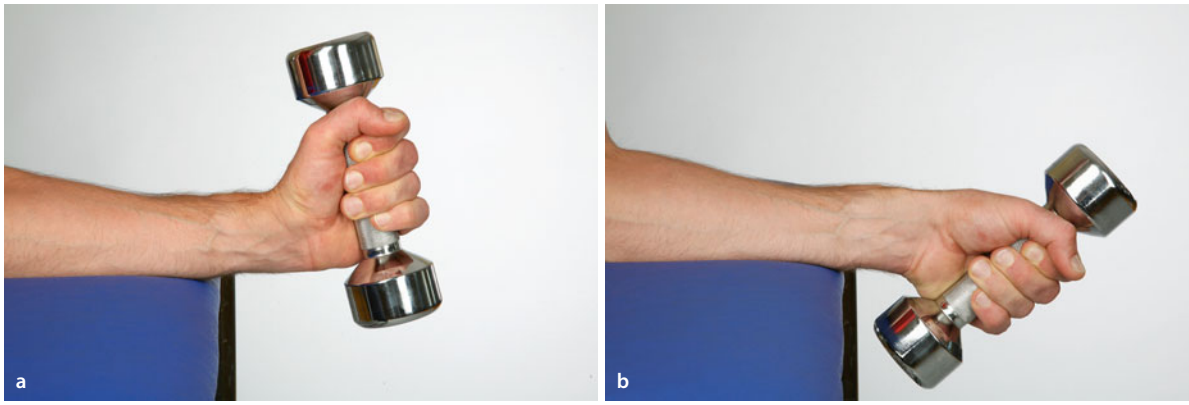

Fig. 5.12a,b Mini dumbbells for wrist flexors and extensors as well as radial and ulnar abductors

Fig. 5.13 Strengthening the core muscles

Physical measures

- Cryocuff.
- Electrotherapy: diadynamic (DF), Träbert, TENS, ultrasound. (**Cave:** Metal implants!)
- Massage of the shoulder-neck muscles.
- Manual lymph drainage.
- Arm water treatment.
- Cryokinetics.

5.2.2 Medical training therapy

- General accompanying endurance training as well as the core and leg muscles (e.g. on the four-point ergometer) (Fig. 5.14).

Sensorimotor function training

- Working on everyday activities (cleaning teeth, hand-mouth coordination, spooning soup).
- Fine coordination without load (e.g., writing).
- Developing the scapular setting (▶ Section 3.1.1).

Fig. 5.14 Training endurance as well as the core and leg muscles on the four-point ergometer

Automobilization

- Mobilization of the thoracic spine through Pilates rolls in supine position or sitting on the tilt table (continuous movement of the lumbar spine, slight movement amplitude).
- In extension (Fig. 5.15).

Strength training

- Initiation of local stabilizers within the permitted range of motion:
  - Supine position, arm supported, with bars in both hands flexion/extension (elbow)
  - Cable pulley frontally, with traction from above, with minimum weight load flexion/extension

Fig. 5.15 Automobilization in extension

- Overflow training via the contralateral side: biceps curls, triceps curls, shoulder muscles (**Cave:** Left surgical side) (Fig. 5.16).
- Intramuscular activation via isometry, isometric holding time (8-10 seconds):
  - Holding exercise using small weights for biceps brachii muscle, wrist extensors/flexors, ulnar/radial abductors with mini-weights (200g) (Fig. 5.17).
- Strength endurance training, 4 x 30 reps.

Fig. 5.17a,b Intramuscular activation via isometry, isometric holding time (8–10 seconds): static work using small weights for wrist extensors/flexors, ulnar/radial abductors against mini-weights (200g)

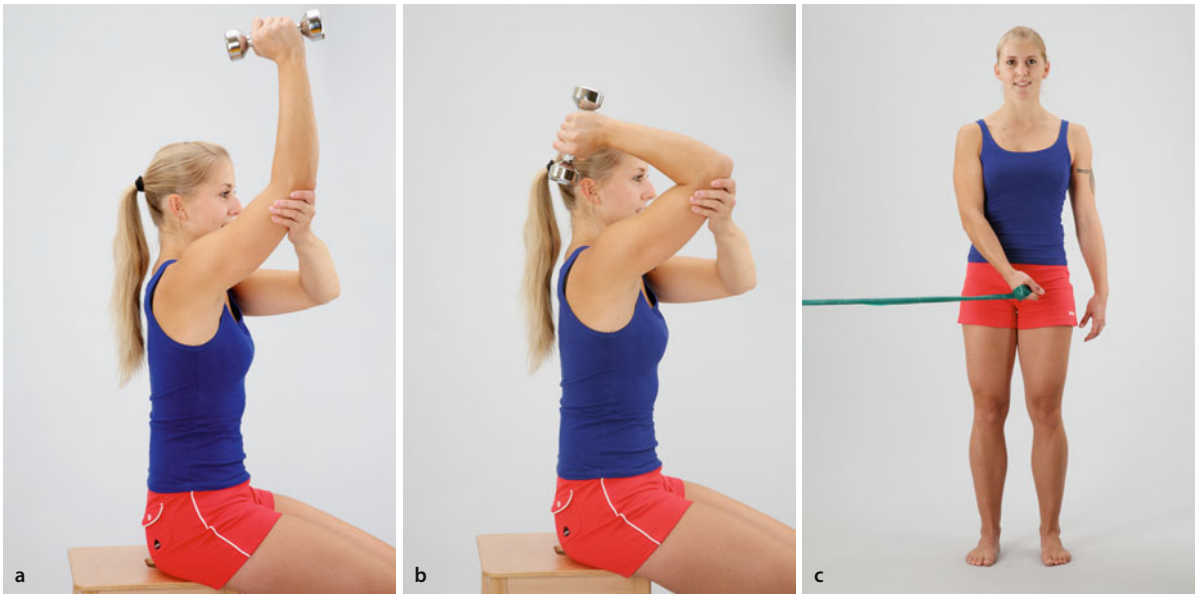

Fig. 5.16a–c Overflow training via the contralateral side: **a,b** Triceps curls, **c** Shoulder muscles

- Shoulder stabilization with short lever above the elbow: controlling with arm rest from cable pulley – direction of motion – retroversion, abduction, flexion.
- Training the finger musculature (therapy putty, theraballs, powerweb, as well as, e.g., piano finger exercises).

5.3 Phase III

Goals of phase III (in accordance with ICF)

Goals of phase III (in accordance with ICF)

- **Physiological function/bodily structure:**
  - **Restoration of joint mobility**
  - **Improving sensorimotor function**
  - **Restoration of dynamic joint stability**
  - **Restoration of muscular strength/endurance**
  - Pain relief
  - Regulation of impaired vegetative and neuromuscular functions
  - Restoring neural gliding ability
- **Activities/participation:**
  - Carrying out daily routine with dynamic stabilization along the entire kinematic chain
  - Learning physiological functional utility model for work, everyday life, sport
  - Promoting mobility (maintaining and changing body position, tips for hand-arm usage)

5.3.1 Physiotherapy

Patient education

- Discussing the content and goals of treatment with the patient.
- Tips on ergonomics in the workplace.
- Instructions regarding the resumption of sporting activities.
- Information for the patient regarding existing restrictions in:
  - Push-ups
  - Powerful throwing: baseball, tennis serve, volleyball.

Improving mobility

- Soft tissue treatment:
  - Fasciae: treatment of anterior and medial neck fasciae, upper arm and forearm fasciae, shoulder fasciae.
- Manual therapy in the nervous area of origin C5-C8:
- Muscles (biceps brachii muscle, triceps brachii muscle, coracobrachialis muscle, brachialis muscle, extensor and flexor group of the forearm, supinators and pronators of the elbow, pectoralis minor and major muscles) through:
  - Functional massage
  - Muscle energy technique (MET)
  - Strain-counterstrain
  - Integrated neuromuscular inhibition technique (INIT)
  - Relaxation techniques from the PNF concept
- Treatment of reflex zones:
  - Manual therapy in the nervous area of origin C5-C8.
- Active movement of the elbow and the hand/lower arm joint against increasing resistance (**Cave:** Endoprostheses).
- Arthrokinetic mobilization: MT during rest and movement (**Cave:** Endoprostheses).
- Independent mobilization in extension, flexion, pronation and supination.

Regulation of vegetative and neuromuscular functions

- Treatment for functional disorders in the key areas:
  - OAA complex (Occiput-atlas-axis)
  - Cervicothoracic transition
  - Thoracic (1-5), costovertebral joints (1-5).
- Treatment of potential trigger points with techniques in accordance with Simons/Travel or INIT.
- Neural mobilization ULNT I–III or Slump.

Improving sensorimotor function

- Awareness exercises and movement training for the spiral screw connection using:
  - Spiral flexion: combination of shoulder joint tension in flexion and internal rotation, with the dynamic supination and flexion of the elbow joint
  - Spiral extension: combination of shoulder tension in flexion, abduction, external rotation with simultaneous pronation and extension in elbow joint.
- Closed system exercises for the synergistic activation and co-contraction of the spine, shoulder girdle, elbow and hand.
- Quadrupedal position with resistance on the distal upper arm or the distal forearm in PNF diagonal patterns (Fig. 5.18).

Weight-bearing is not permitted. No lifting of loads of greater than 5kg or consistently repetitive lifting of 1kg weights! Better: standing by a table, with had supported and the other hand grasping, e.g., for a cup.

Fig. 5.18a,b Quadrupedal position with resistance **a** On the distal upper arm **b** On the distal forearm in PNF diagonal patterns

Fig. 5.19 Support function training on the mat

- Support function on the floor:
  - Soft mat (Fig. 5.19)
  - Redcord® system
  - Haramed
  - Propierig.
- Climbing rocks.

Goal-oriented movement enables the feed-forward innervation of the primary stabilizing muscles (stabilizers). Movement exercises should therefore be performed in everyday situations.

- Improving elbow flexion and extension with the help of dynamic rotation against guided contact.
- Where turning movements are permitted: timing for emphasis for weaker muscles, e.g., entire arm pattern of flexion-adduction-external rotation with an emphasis on the supination to improve intramuscular and intermuscular coordination.

Stabilization and strengthening

- Segmental stabilization via the deep neck flexors.
- Strengthening the scapular fixators.

Fig. 5.20 Exercises using the cable pulley/Vitality® band

- Strengthening the flexor carpi ulnaris muscle, flexor digitorum superficialis muscle, pronator teres muscle to relieve the medial ligaments.
- Strengthening extensor digitorum muscles, extensor carpi ulnaris muscle to relieve the lateral ligaments.
- Exercises using the cable pulley/Vitality® band (Fig. 5.20).
- Hand and arm pattern.
- Integrating strength training into the kinematic chain: e.g., into throwing position, putting position (golf, ice hockey, tennis) (Fig. 5.21).
- Exercising with Boing, Bodyblades or Propriomeds to activate co-contraction in different functional starting positions.

Fig. 5.21 Integrating strength exercises into the kinetic chain: Throwing exercise

- Begin by training reactive neuromuscular control for dynamic joint control (plyometrics):
  - Dribbling against the wall
  - Supporting against a Pezzi ball held against the wall
  - Wall push-ups (Fig. 5.22).
- Variable plank actions with and without additional tasks (Fig. 5.23).

Fig. 5.23a,b Variable plank actions with and without additional tasks

- Closed system exercise on unstable support surfaces:
  - Plank on Haramed (Fig. 5.24)
  - Plank on Posturomed or soft mat with additional tasks.

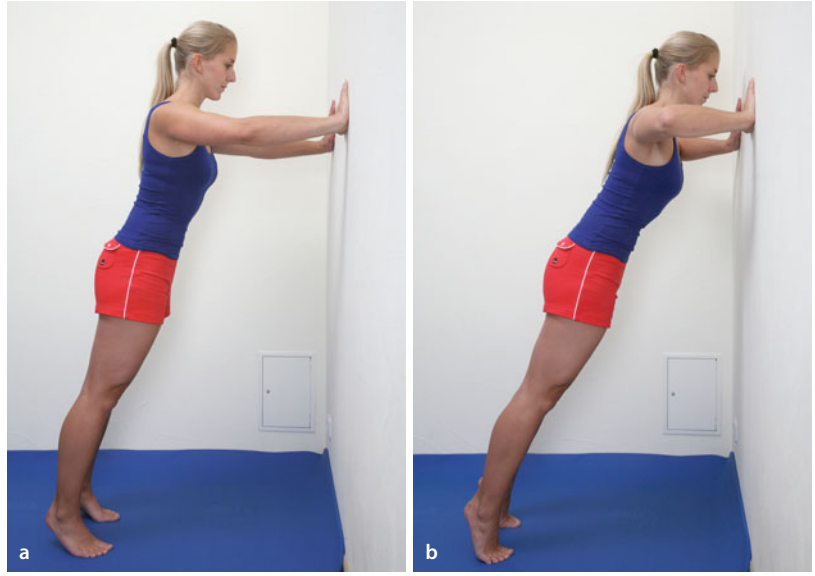

Fig. 5.22a,b Training reactive neuromuscular control for dynamic joint control (plyometrics) with wall push-ups

Fig. 5.24 Closed system exercise on unstable support surfaces: Plank on Haramed

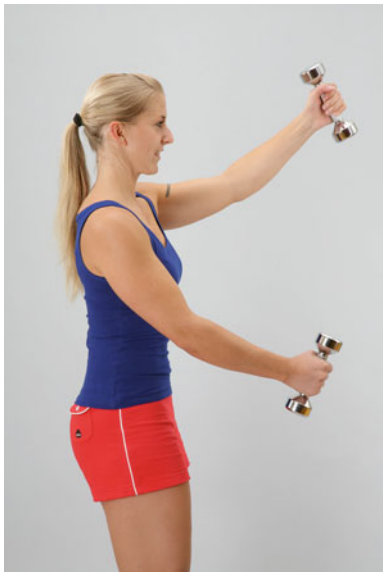

Fig. 5.25 Exercising in open system with dumbbells

Strengthening the individual muscle groups in open and closed system with small equipment (dumbbells, space ball, boing, bodyblades etc.) or also with hand ergometer, rowing machine etc.

- Exercising in open system: with space ball, hand pattern, dumbbells (Fig. 5.25).

Bear weight on the arm that underwent surgery very carefully. Begin with lower weights!

- Integrating strength training into kinematic chain: e.g., into throwing position, putting position (golf, ice hockey) (Fig. 5.26).

Physical measures

- Massage.
- Cryokinetics.

Fig. 5.26 Integrating strength exercises into the kinetic chain in putting position

- Electrotherapy (EMS, TENS).
- Ice.
- Hot rolls.
- Applying heat locally or reflectively.

5.3.2 Medical training therapy

- General accompanying training of endurance as well as the core and leg muscles.

Sensorimotor function training

- Fine coordination with load or speed (e.g., juggling, balancing a bar etc.).
- Unstable environments (e.g., support on Pezzi ball, forearm plank on Aerostep etc.).
- Developing precision control (ability to control movements precisely, e.g., grabbing bars at different heights/distances/weights, catching various objects, moving/lifting various things without visual checking, etc.).
- Developing the scapular setting.

Strength training

- Strength endurance training of the local stabilizers during warm-up (biceps brachii muscle, triceps brachii muscle, brachialis muscle).
- Muscle building training for general musculature.

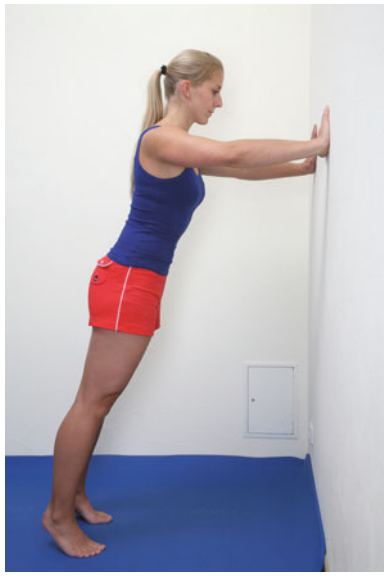

Fig. 5.27 Working on planks: Standing against the wall

- Working on planks, hanging, pulling, pushing etc.
  - Support in kneel position, transferring weight between hands, standing against the wall (Fig. 5.27)
  - Grip alternatives climbing rocks (Fig. 5.28)
  - Reverse push-up on the wall bars
  - Push-up on the wall bars
  - Weight-supported pull-ups.
- Hypertrophy training within a medium range of motion, in completely pain-free range! (approx. 4–6 weeks, 6 x 15 reps or in the form of pyramid training 18/15/12/12/ 15/18).
- Intramuscular coordination training (approx. 4–6 weeks, 6 × 3–5 reps, average range of motion).
- Hypertrophy training (6 x 15 reps, or as pyramid training 18/15/12/12/15/18), overflow via the contralateral side.
- Training the following muscles: Biceps muscle, triceps muscle, coracobrachialis muscle, brachialis muscle, forearm rotators, wrist extensors/flexors (roll-up with traction roll) (Fig. 5.29).
- Chest press, bench press, rowing, dip machine, latissimus pull machine, Vitality® band, gym stick (Fig. 5.30).

Therapeutic climbing

- Grip changing training in different directions.
- Grip fixation training with dynamic shift in body weight against the wall.
- Grip fixation training in different directions.
- Sport-specific conditioning (dribbling basketball, throw-ins for soccer, grip stabilization tennis) (Fig. 5 31).

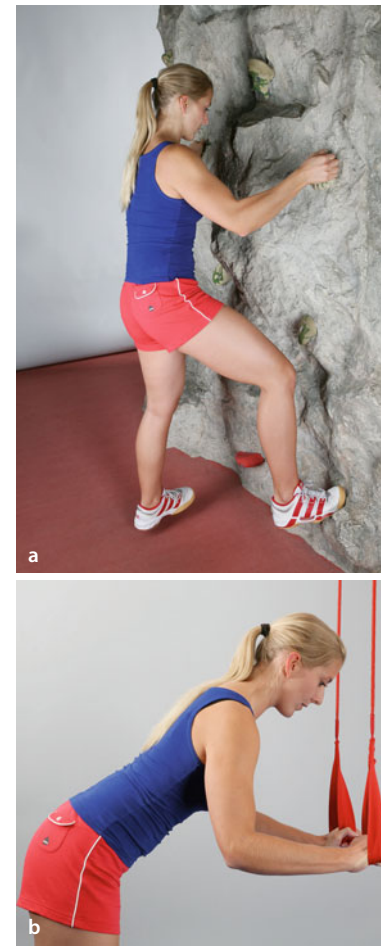

Fig. 5.28a,b Grip alternatives climbing rocks

Fig. 5.29 Training biceps muscle, triceps muscle, coracobrachialis muscle, brachialis muscle, forearm rotators, wrist extensors/flexors through roll-up with traction roll

Fig. 5.30 Strength training with gym stick

Fig. 5.31 Sport-specific conditioning: grip stabilization tennis

- Grip changing training in different directions.
- Grip fixation training with dynamic shift in body weight against the wall.
- Grip fixation training in different directions in the negative wall area.

5.4 Phase IV

5.4.1 Sports therapeutic content for the upper extremity

The following section refers to the rehabilitation of the entire upper extremity.

General

- Continuously checking that humeral head centering is correct and scapular setting.
- Spreading strength training units over muscle groups and different days.
- Observing classic training principles.
- Inclusion/coordination with competition planning/periodization.
- Controlling load via the sequencing of various exercises rather than series of exercises, e.g., flies, overhead pulls, inclined bench presses.
- Integrate sport-specific exercises into each training session.
- Develop sport-specific training methods methodically.

Sensorimotor function training

- Integration into each training unit following the warm-up stage.
- Whole body stabilization exercises with high requirements (Fig. 5.32).
- Feed forward training (e.g., throwing balls of different weights, different objects, fall training) (Fig. 5.33).
- 3D fine coordination: e.g., dynamic grip/steps on climbing wall, catching balls on acoustic signal).
- Physical awareness from sport-specific movement (internal sensorimotor and attributed error analysis), comparing errors in own/external and video analysis.
- Unstable environments, increased requirements (e.g. push-up on Haramed, juggling while pedalo boating) (Fig. 5.34).

Strength training

- Preparing for exercise by practicing the type of load with a lower weight.
- Maximum strength training of the global muscles (two to three times per week/determining intensity via a maximum of one repetition):
  - Intramuscular coordination training (full range of motion, 6 x 3-5 reps):
    - Equipment-supported (e.g. dips, rowing)
    - Weights training (e.g., biceps curls, bench presses, rowing)
  - Speed and reaction speed training, explosive loads: push-up jumps, reactive loads (e.g., turns)
  - Training the local stabilizers (dynamic as functional endurance builder, high number of repetitions with low intensity), rotation of the shoulder (cable pulley training for internal shoulder rotation, Fig. 5.35a), Stabilizers of the elbow (Fig. 5.35b):
    - Multi-directional training from variable starting positions, bench press, pull-ups, push-up with load (Fig. 5.36).
- Reactive catching of light balls or with Stonies® as a more advanced option in external rotation and supine position. The therapist allows the weights to fall (Fig. 5.37).

Fig. 5.32a–e Whole body stabilization exercises with high requirements

- Throws:
  - Throwing from standing position with light balls, slowly
  - Throwing during movement with normal balls, slowly
  - Throwing at a target (precision pressure)
  - Throwing from movement with acceleration (time pressure)
  - Two-armed throwing simulation with torso rotation (Fig. 5.38)
  - One-armed throwing simulation: cocking acceleration follow through (Fig. 5.39)
- Catching and immediately throwing again (situation pressure) (Fig. 5.40)
  - Complexity pressure
  - Plyometric training (pre-stretching + maximum contraction with competition-specific movement): Structure: 1. General; 2. Various targets; 3. Specific. Tennis player example: 1. One-armed barbell rotation 2. Throwing and holding weights (stopping) 3. Tennis serve with maximum quality.
- Reactive-situative loads, training in the stretch-shortening cycle (SSC): spiking or serving in volleyball (Fig. 5.41), tennis serve, judo, push-hands from Tai Chi, boxing, blocking in basketball, throwing position in handball.
- Development of condition variables:
  - Precision control (e.g., accuracy of ball throwing)

Fig. 5.33a,b Feedforward training. **a** Throwing balls of varying weights, **b** Fall training

Fig. 5.34a,b Increased requirements through unstable environments. **a** Push-up on Haramed, **b** Juggling on unstable support surfaces

Fig. 5.35a,b Training local stabilizers. **a** Cable pulley training for internal shoulder rotation, **b** Barbell stabilizers for the elbow stabilizers

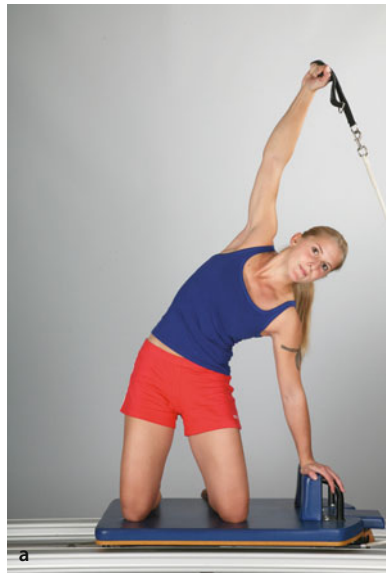

Fig. 5.37 Reactive catching of light balls in external rotation and supine position. The therapist allows the weights to fall

Fig. 5.36a,b Multi-directional training from variable starting positions **a** On the reformer, **b** On the sling system

- Time control (e.g., 30 times or seconds Bouncing a basketball)
- Situation control (e.g., choice of responses to a signal)
- Complexity control (e.g., ice hockey passing against defender) (Fig. 5.42).

- General accompanying training of endurance as well as the core and leg muscles.
- Sport-specific competitive training.

Therapeutic climbing

- Free climbing training with adjusted routes (Fig. 5.43).

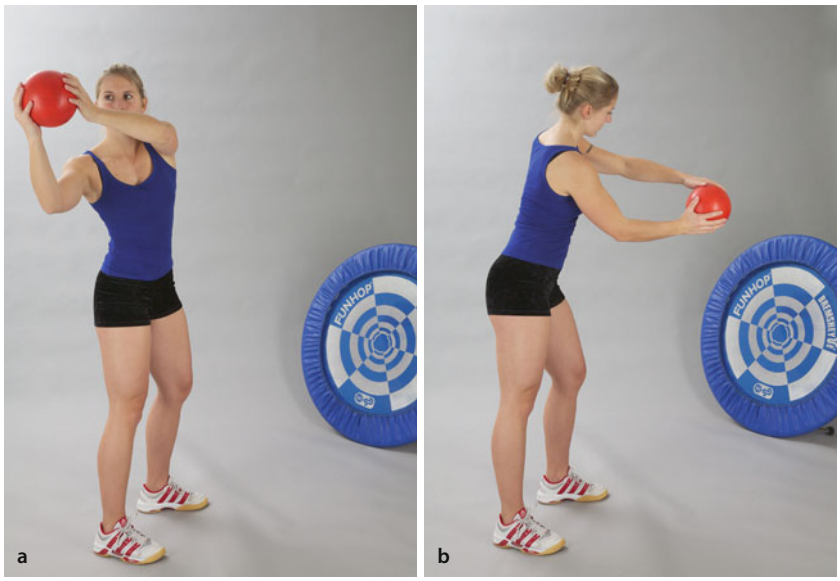

Fig. 5.38a,b Two-armed throwing simulation with torso rotation

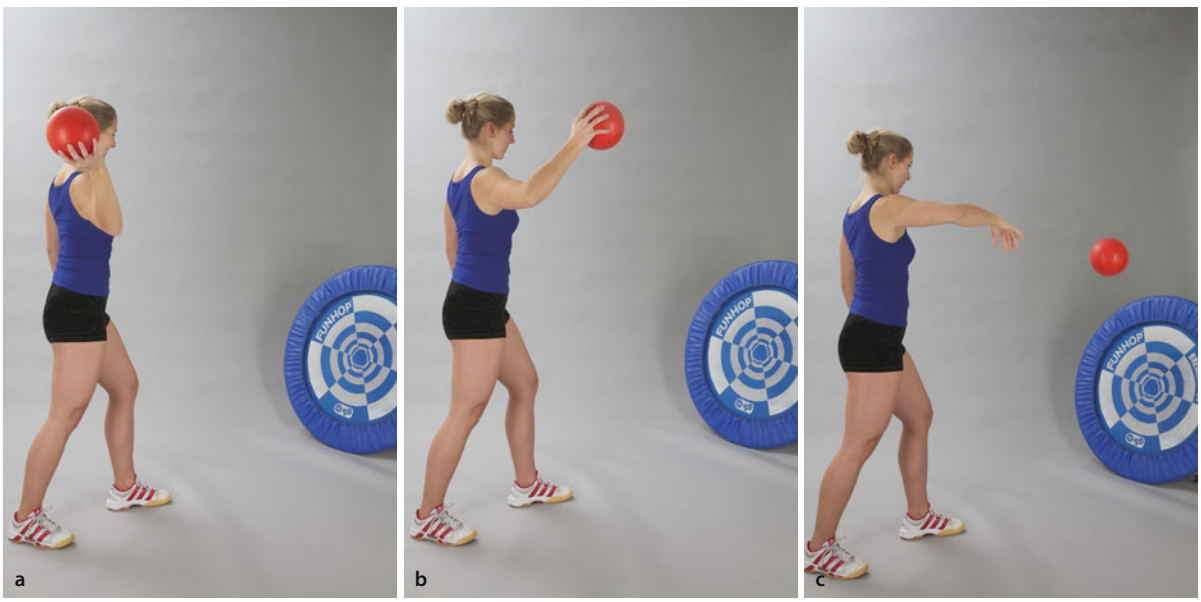

Fig. 5.39a–c One-arm throwing simulation. **a** Cocking, **b** Acceleration, **c** Follow through

Fig. 5.40 Catching and immediately throwing again

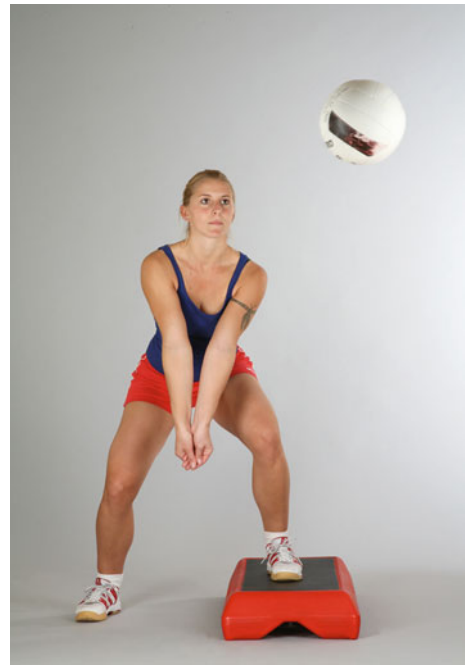

Fig. 5.41 Reactive-situative loads, training in the stretch-shortening cycle (SSC): serving in volleyball

Fig. 5.42a–c Developing complexity control

Fig. 5.43 Free climbing training with adjusted routes

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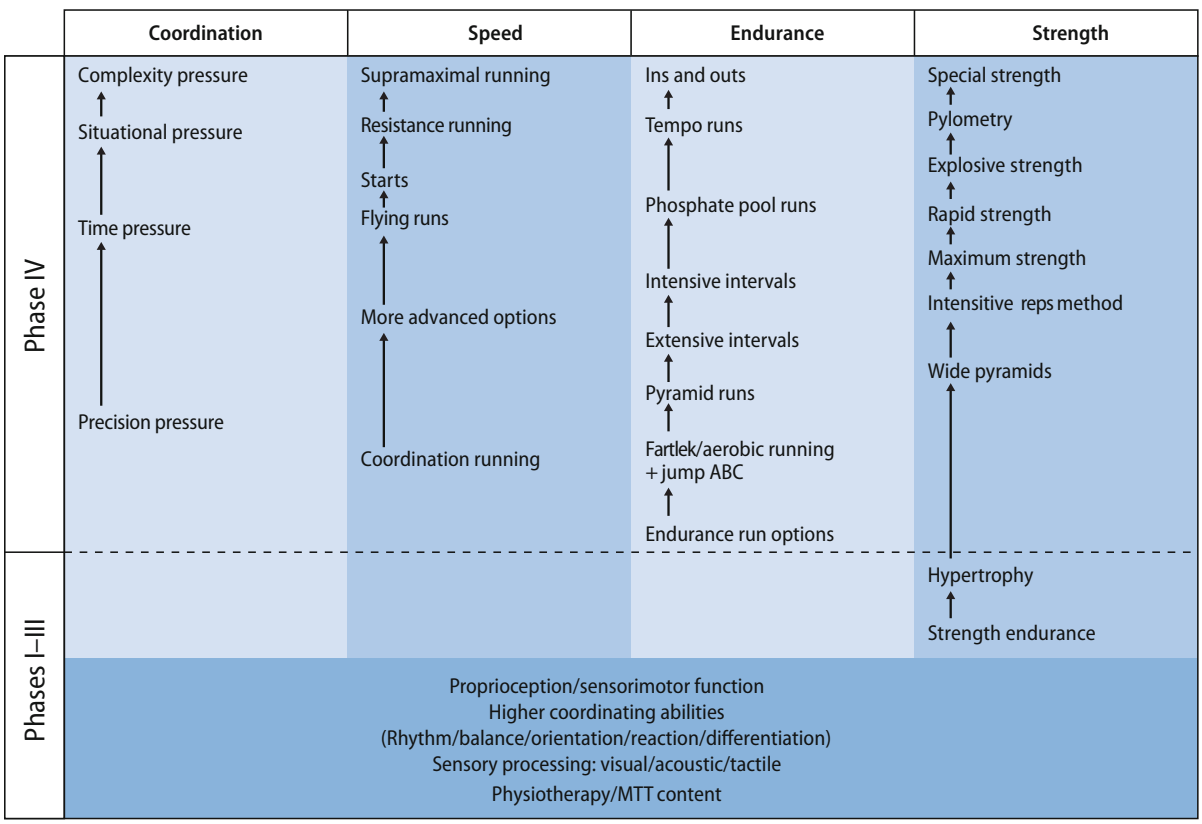
Lower extremity

Strategy for the rehabilitation of the lower extremity (stages I-IV)

- Ensuring the success of the operation:
  - Patient education
  - Anatomical, biomechanical, pathophysiological and neurophysiological knowledge (wound healing phases, tissue regeneration time etc.)
  - Knowledge of the surgical procedure
  - Patient/athlete compliance.
- Improving mobility.
- Neuromuscular control.
- Sensorimotor function/coordination/fine coordination/gait.
- Coordinating the entire lower extremity with core involvement.
- Training strength, endurance and speed of the lower extremity/core (rehab phase IV).
- Jumps.
- General and sport-specific training.

Weighting of treatments over the different phases			
	Phase II	**Phase III**	**Phase IV**
Physiotherapy	25%	15%	5%
Sensorimotor function	25%	35%	25%
Strength training	15%	20%	35%
Sport-specific training	15%	10%	25%
Exercising local stabilizers	20%	20%	10%

Training content of sports therapy of the lower extremity



- The content is divided into four conditional areas of coordination/speed/endurance/strength.
- Each area begins with proprioception or sensorimotor function and ends once all stages have been passed through. No points are to be skipped, where possible.
- In addition, the areas are connected in parallel, i.e., the content for strength also applies to the same level of endurance, coordination and speed.

Hip: Surgical procedure/aftercare

Andreas B. Imhoff, Knut Beitzel, Knut Stamer, Elke Klein

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6.1 Endoprosthesis

6.1.1 Superficial hip replacement

Indication

- Coxarthrosis in younger patients without bone deformity of the femoral neck.

Surgical method

- Pre-surgery planning with a pelvic X-ray.
- Antero-lateral access.
- Procedure between tensor fasciae latae and gluteus medius muscles on the ventral joint capsule.
- Incision of the capsule ventrally and dorsally on the acetabulum.
- Determining the size of the cap and luxation of the hips dorsally in a muscle pocket below the gluteus minimus muscle.
- Rraising of the acetabulum, adjusted to the measured size of the onlay on the femur head.
- Implantation of the acetabulum. Inserting the metal inlay.
- Cementing the onlay to the femural head with low-viscosity cement.
- Reduction and wound closure layer by layer.

Aftercare

Table 6.1 provides an overview of aftercare.

6.1.2 Hip TEP standard

Indication

- Coxarthrosis.
- Femoral neck fracture.
- Prosthesis loosening.

Surgical method

- Antero-lateral access (also minimally invasive in the case of primary prostheses).
- Procedure between tensor fasciae latae and gluteus medius muscles on the ventral joint capsule. Excision of the capsule.
- Dislocation of the hip and femoral neck osteotomy.
- Milling the acetabulum and implanting the socket (primarily without cement if possible, rarely cemented). Insertion of an inlay (ceramic or polyethylene).
- Preparing the hip shaft with graters until the prosthesis stem fits properly (primarily without cement where possible, with cement in rare cases in the case of insufficient bone quality).
- Determining length and placing a prosthesis head (ceramic or metal).
- Wound closure layer by layer. Spica bandage.

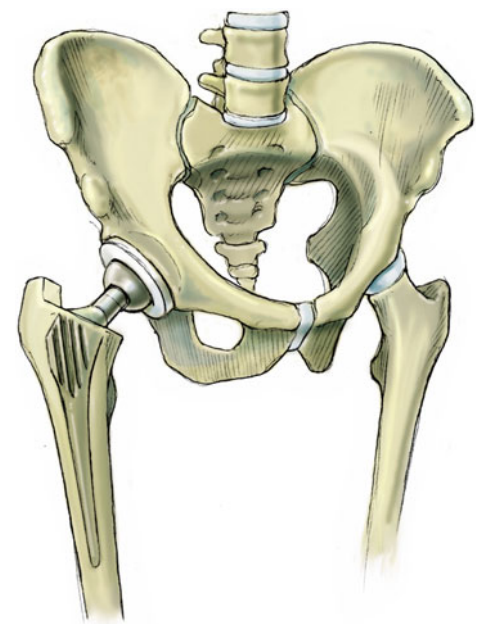

Fig. 6.1 Total endosprothesis of the hip joint

Table 6.1 Surface hip replacement. No specific orthosis therapy required

Phase	Range of motion and permitted load	
I	from 1st day post-op:	Standing up under full load
II	1st to 6th weeks post-op:	Avoid sitting deeply and adduction/ER movements of the hips
III	approx. 7 weeks post-op:	Cycling, front crawl
IV	approx. 3 months post-op:	Resumption of sport and sport-specific training (personal treatment decision)
		Contact and high-risk sports not recommended Aftercare

Table 6.2 Hip TEP standard. No specific orthosis therapy required

Phase	Range of motion and permitted load	
I	from 1st day post-op:	Standing up under full load (in consultation with the surgeon)
II	1st to 6th weeks post-op:	Avoid sitting deeply and adduction/ER movements
III	approx. 7 weeks post-op:	Cycling, swimming (crawl)
IV	approx. 3 months post-op:	Resumption of sport and sport-specific training (personal treatment decision following consultation with a doctor)
		Contact and high-risk sports not recommended

Aftercare

Table 6.2 provides an overview of aftercare.

6.2 Osteotomies

6.2.1 Osteotomy near the hip joint: Triple pelvic osteotomy

Indication

- Hip joint dysplasia (insufficient covering of the femoral head by the acetabulum).

Surgical method

- Begin with dorsal access (approx. 10cm) along the muscle fibers of the gluteus maximus muscle via the ischium.
- Diagonal osteotomy of the ischium above the sacrospinal ligament.
- Wound closure layer by layer.
- Ventral access via the pubic bone. Pubic bone osteotomy, wound closure layer by layer.
- Ilioguinal access to ilium wing. Medial removal of the inguinal ligament in muscle loop group.

Presenting the sciatic notch through a subperiostal approach medially and laterally above the acetabulum.

- Osteotomy above the acetabulum and orientation of the socket fragments, depending on the main components of the deformity, until the femoral head is better covered.
- Osteosynthesis (generally with screws through the ilium into the acetabulum).
- Wound closure layer by layer.
- Applying a spica bandage and a Newport orthotic (flexion/extension: 20°/20°/20°).

Aftercare

Table 6.3 provides an overview of aftercare.

6.2.2 Proximal femur osteotomy

Indication

- Hip joint dysplasia (steep position of the femoral neck).
- Legg–Calvé–Perthes Disease (aseptic bone necrosis of the epiphysis in childhood).

Table 6.3 Triple pelvic osteotomy. Newport orthotic for twelve weeks post-op flexion/extension: 20°/20°/0° for six weeks; for a further two weeks flexion/extension: 60°/0°/0°, finally: flexion/extension: 90°/0°/0°)

Phase	Range of motion and permitted load	
I	from first day post-op:	Isometric exercising of the muscles Standing next to the bed briefly
II	for 6 weeks post-op:	Pressure relief
III	Up to twelve weeks post-op:	Increase weight load by 15kg/week under radiological supervision
	from 12 weeks:	Full load and free mobility (following consolidation of the osteotomy)
IV	approx. 4 months post-op:	Beginning with gentle sports activity (cycle, crawl swimming)
	approx. 6 months post-op:	Resumption of sport and sport-specific training (following consultation with a doctor)
	approx. 9 months post-op:	Contact and high-risk sports to the extent possible

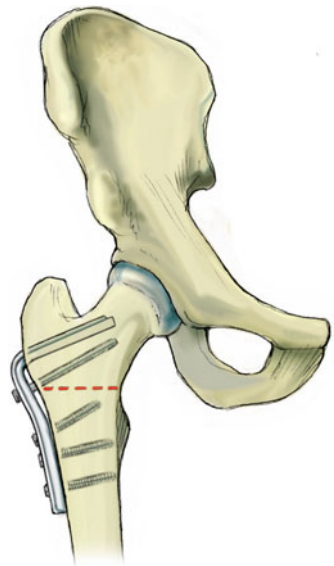

Fig. 6.2 Corrective proximal femur osteotomy and osteosynthesis using angle plate

- Slipped capital femoral epiphysis from a slip angle of 30° (detachment of epiphysis).
- Necrosis of the femoral head.

Surgical method

- Lateral access to the greater trochanter and proximal femur.
- Mostly intertrochanteric osteotomy. Shift or valgus with additional rotation or tilting (flexion/extension) depending on the underlying pathology.
- Taking a small piece of bone is possible.
- Osteosynthesis that remains stable during exercise with an angle plate. Wound closure layer by layer.

Aftercare

Table 6.4 provides an overview of aftercare.

6.3 Impingement therapy on the hip joint

6.3.1 Labrum and femoral neck therapy

Indication

- Femuro-acetabular impingement.
- Tear in the labrum.

Surgical method

- Access dependent upon the location of the pathology (directly anterior or anterolateral).
- Anterolaterally: approx. 13cm long incision along the anterior limit of the gluteus medius muscle. Procedure between gluteus and tensor fasciae latae muscles on the anterolateral joint capsule.
- Anterior: Skin incision of the anterior superior iliac spine approx. 13cm distally. Procedure between sartorius and tensor fasciae latae muscles. Detachment of the rectus origin on the ventral acetabulum and the anterior inferior iliac spine.

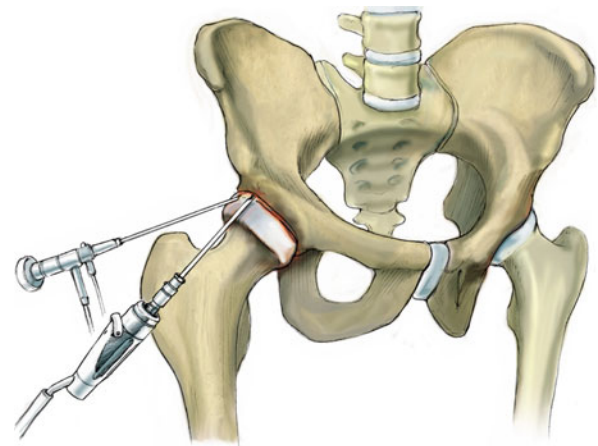

Fig. 6.3 Arthroscopic treatment of the femuro-acetabular impingement

Table 6.4 Femur osteotomy. No specific orthotics necessary

Phase	Range of motion and permitted load	
I	from 1st day post-op:	No weight bearing for six weeks post-op
II	from six weeks post-op:	Increase weight load (20kg/week) with radiologically visible consolidation of the osteotomy
II	approx. 4 months post-op:	Beginning with gentle sports activity (cycle, crawl swimming)
	approx. 6 months post-op:	Resumption of sport and sport-specific training (following consultation with a doctor)
IV	approx. 9 months post-op:	Contact and high-risk sports

Table 6.5 Labrum and femoral neck therapy: open approach. No specific orthosis therapy required

Phase	Range of motion and permitted load	
I	from 1st day post-op:	Free mobility depending on the degree of pain Avoiding hyperextension
	for 2 weeks post-op:	Pain-dependent partial load 20kg
II	from 3rd week post-op:	Depending on the circumference of the femoral neck, gradual increase in load up to the sixth week post-op
III	approx. 7 weeks post-op:	Jogging (running training), cycling, swimming (crawl)
IV	approx. 3 months post-op:	Resumption of sport and sport-specific training (following consultation with a doctor)
	approx. 6 months post-op:	Contact and high-risk sports

Table 6.6 Labrum and femoral neck therapy: arthroscopic approach. No specific orthosis therapy required

Phase	Range of motion and permitted load	
I	for 2 weeks post-op:	Partial load (20kg)/free range of motion
II	from 3rd week post-op:	Depending on the circumference of the femoral neck, gradual increase in load up to the sixth week post-op (in the case of the reconstruction of the labrum: flexion <90°, especially avoiding combined IR, adduction and flexion movements and hyper extension for six weeks post-op)
III	approx. 7 weeks post-op:	Jogging, cycling, swimming (crawl)
IV	approx. 3 months post-op:	Resumption of sport and sport-specific training (following consultation with a doctor)
	approx. 6 months post-op:	Contact and high-risk sports

- Z-shaped incision in the capsule and presentation of the labrum, acetabulum edge and femoral neck.
- Resection of the tear in the labrum and of acetabular osteophytes, circumference of the femoral neck on the bone-cartilage transition until no visible impingement can be seen any more when moving the hip joint.
- Wound closure layer by layer.

Aftercare

Table 6.5 and Table 6.6 provide an overview of aftercare.

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Hip: Rehabilitation

Andreas B. Imhoff, Knut Beitzel, Knut Stamer, Elke Klein

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7.1 Phase I

The following description of rehab phase I can apply to all postoperative aftercare for operations on the lower extremity.

Goals (in accordance with ICF)

Goals of phase I (in accordance with ICF)

- **Physiological function/bodily structure:**
  - **Pain relief**
  - **Promoting resorption**
  - **Improving joint mobility**
  - **Avoiding functional and structural damage**
  - Regulation of impaired vegetative and neuromuscular functions
  - Improvement in functions affecting sensorimotor function
  - Improving dynamic joint stability
- **Activities/participation:**
  - Learning change of position as needed for surgery
  - Learning to walk on crutches in line with the load plans
  - Independent care in daily life
  - Reducing fear of moving (tips and info)
  - Learning a home training program

7.1.1 Physiotherapy

Patient education

- Discussing the content and goals of treatment with the patient.
- Pain management with the goal of becoming pain-free (physiological pain processing):
  - Treatment within the pain-free range
  - Holding in a pain-free position.
- General position control:
  - Holding in neutral rotation position: When the hip joint is in external rotation position, in principle there is the risk of a compression of the deep peroneal nerve behind the fibular head!
  - **Hip endoprosthesis:** In a foam cast, the leg should be held with the hip joint in neutral rotation setting and slight abduction (rest position)
  - **Muscle refixation:** Precise adaption of the Newport orthotic, so that the refixed muscles can relax. In supine position and lateral position, well-supported with additional cushions or covers. Hold in a pressure-free position
  - **Transposition osteotomies of the knee joint:** No raising of the lower leg against distal resistance, no rotation (turning with stationary leg)
  - **Arthrolysis (knee joint):** The active cooperation of the patient is of particular importance here: consistent stretching, mobilization and support are essential for the achievement of the best possible surgical result. A great deal of motivation on the part of the patient is therefore often necessary. In this specific case, pain-free treatment is not always possible: concomitant treatment with analgesics is recommended.

Practical tip

Posture tips

- **In case of extension deficit in the knee joint:** with a cushion or similar, the distal lower leg can be supported in such a way that the heel and popliteal space lie freely. In addition, the distal thigh can be ventrally weighted with a beanbag. Also possible if a Quengel splint is to be placed at the same time.
- **In case of flexion deficit in the knee joint:** CPM (continuous passive motion): disengage splint in flexion and use Quengel hinge with an additional beanbag on the distal lower leg. After a few minutes, return to flexion and disengage at new motion stop.

- Providing the patient with further information regarding the limitations and requirements associated with the operation:
  - **Hip endoprosthesis:**
    For three months, it is not permitted to raise the stretched leg. During movement transitions or when raising the extremity, the leg that underwent surgery is supported by the foot that did not undergo therapy on the distal lower leg
    Avoiding adduction for three months (legs may not be crossed). Rotation on the side that did not undergo surgery is permitted after one week at the earliest: A cover between the legs prevents the adduction of the leg that has undergone surgery
    For approx. three months, flexion in combination with external rotation endangers luxation, as the replacement capsule tissue has not yet sufficiently formed
    In principle: Sticking to load and movement plans
  - **Labrum refixation and impingement therapy:** No hyperextension for six weeks due to rectus detachment, there is an additional restriction of movement in the case of labrum refixation; no combined flexion, adduction or internal rotation and flexion only up to 90° for six weeks.

It takes between ten and twelve weeks for a resilient capsule replacement tissue to form!

- Informing the patient about his/her personal condition using visual aids (mirror, knee/hip/ankle model), tactile support and verbal feedback. If the patient understands the problem, they will be much more motivated and willing to cooperate!
- Learning movement transitions through joint-stabilizing muscle tension.
- Learning to walk on crutches in line with the procedure.

Even if full load would be possible in some operations based on the intervention, it is sensible to adopt a three-point gait crutches as the surgical procedure results in issues with coordination and proprioception, and consideration should be paid to wound healing.

Prophylaxis

- Early mobilization from bed while taking the load guidelines into account. Due to the tendency for swelling, little but often is preferable to once for a long period.
- Instruction on SMI trainer, deep breathing techniques such as nose stenosis, "sniffing" inhalation, breathing control, etc.
- Active terminal movement in the ankle joints at second intervals.
- Active movement of the upper extremity: the exercises should be performed independently once per hour as local endurance training.
- Isometric training of the leg muscles.
- Instructing the patient how to perform the exercises independently, specifying the precise number of repetitions, intensity and rest duration.

Promoting resorption

- Activating the muscle pump through the firm movement of the ankle joints.
- Isometric tensioning of the entire leg muscles once per second (where allowed).
- High position, where possible above heart height: using foam cast or raising the foot of the bed.

- **Cases of high tibial and supracondylar transition osteotomies may result in increased hematoma formation due to the major surgery on the soft tissue and osteotomy.**
- **In the case of increased swelling or pain, and a decrease in function of the foot flexor, consider the development of compartment syndrome!**

- Manual lymph drainage.
- Smooth suction massage with suction cup along the lymphatic pathways to relieve congestion.
- Cryokinetics: Alternating rubbing ice on the skin briefly (approx. 20 seconds) with low-lift therapeutic movement exercises (approx. two minutes), approx. 3-4 repetitions per treatment unit.

Improving mobility

- Passive and assistive movement in accordance with the procedure under decreased weight within the pain-free range.
- Mobilization in sling table through pelvic leg suspension (not in the case of pelvic operations).
- Counter-bearing mobilization from the functional kinetics concept.
- Promoting mobility in the hip joint by working via the proximal lever with techniques from the PNF concept:
  - Starting in lateral position: to improve the flexion and internal rotation of pelvic patterns (with a cover between the legs to prevent adduction) in posterior depression
  - Starting in lateral position: pelvic pattern in anterior elevation to improve extension in the hip joint (not in the case of pelvic operations).
- Mobilization of the patella (Fig. 7.1).
- Manual mobilization of the suprapatellar recess and isometric tensioning of the quadriceps muscle facilitates adhesion between the superficial and deep layer. Monitoring: Does the patella move cranially when tensed?
- Soft tissue treatment:
  Detonization of hypertonic and shortened muscles:
  (**Cave:** In the case of muscle refixations):
  - Quadriceps femoris muscle
  - Popliteus muscle
  - Gastrocnemius muscle

Fig. 7.1 Mobilization of the patella

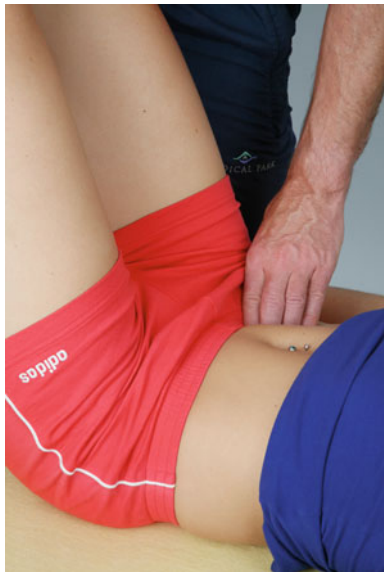

Fig. 7.2 Detonization of hypertonic and shortened muscles: Psoas muscle

- Ischiocrural muscles
- Iliotibial tract
- Iliacus muscle
- Psoas muscle (Fig. 7.2).

- Retaining the mobility of the neighboring joints.

- In the case of high tibial transition osteotomies the mobility of the ankle joint can be restricted as a result of the fibular osteotomy.
- In the case of hip operations, knee mobility may be reduced through reflectory hypertension of the vastus lateralis femoris muscle and iliotibial tract due to the surgical access.

Regulation of vegetative and neuromuscular functions

- Treatment in the orthosympathetic and parasympathetic areas of origin: Th8–L2 and S2–S4:
  - Manual therapy to mobilize the thoracic spine and rib joints
  - Physical therapy: massage, hot rolls, electrotherapy, connective tissue massage, cupping glass therapy.
- Intramuscular exertion of influence via passive/actively assisted movement within the pain-free range.
- Passive movement within pain-free range as well as traction and compression from MT as stimulus for the regeneration of the synovial membrane of the joint capsule.

Fig. 7.3 Exploiting overflow via the core and the extremities that did not undergo surgery using techniques from the PNF concept

Improving sensorimotor function

- Neuromuscular control of the stabilizing muscles (**Cave:** In the case of muscle refixations).
- Proprioception/kinesthesia training, e.g., placing, mirroring.
- Perception training for patients following hip joint endoprosthesis implants:
  - Starting in supine position:
    Perceiving the leg in rest position
    Assisted movement of the leg alongside the therapist from abduction into the permitted adduction neutral position with open eyes
    The patient closes his/her eyes as soon as the therapist has brought the leg from abduction position into neutral adduction position.
- Minimal dose of compression level 1 from MT as afferent sensomotory input (**Cave:** Not in the case of implants of hemi/total endoprostheses).
- Exploiting overflow via the core and the extremities that did not undergo surgery, for example using techniques from the PNF concept (Fig. 7.3).
- 3D foot perception: e.g. 'Perpendicular heel' exercise (Spiraldynamik) for training the correct heel position.
- Promoting sensorimotor function through closed chain sensomotoric exercises.
- Electro-muscular stimulation (EMS).
- Activation of the vastus medialis oblique muscle (VMO) with manual guided contact in the fiber flow to the medial-cranial side of the patella (45° on the course of the rectus).

Stabilization and strengthening

- Following operations on the knee joint: learning co-contraction of quadriceps femoris muscle and the ischiocrural muscles for movement transitions.

Fig. 7.4 Leg axis training with relaxation or permitted load in supine position

Fig. 7.5 Stabilization training in typical walking positions

- Isometry for quadriceps femoris muscle (alternatively 8-10 seconds, maximum isometric tensioning per permitted activity).
- Strengthening the entire pelvic and leg muscles: abductors, adductors, gluteals, ischiocrural muscles starting in supine position, lateral position, prone position.
- Learning three-point foot weight-bearing as a basis for the leg axis, with static core involvement.
  Task: Imagine that there is a tensed band between the heel and the metatarsophalangeal joint of the big toe that you want to push forwards with the heel. The contraction of the tibialis anterior muscle is not desired.
- Leg axis training with relaxation or permitted load in supine position, sitting, half-standing position (Fig. 7.4).
- Stabilization training in typical walking positions (modified depending on the procedure) (Fig. 7.5).

Gait

- Learning three-point gait on flat surfaces and on stairs.
- Learning four-point gait under permitted full load.
- Training movement transitions: use of the "leg crane". When standing up or sitting down, the patient should learn to place the leg that underwent surgery in front of the other in order to prevent undesired strain or movement.
- Training the support activity of the arms to help with walking on crutches:
  - Starting in lateral position/seated: scapular pattern bilaterally
  - Starting in supine position/seated: arm pattern in extension-abduction-IR
  - Instructions for independent exercising with the Vitality® band.
- Ascend step with sidestep: "Healthy goes up – injured goes down".

Physical measures

- Manual lymph drainage/lymph taping.
- Partial massage: should the unaffected leg be overburdened or in the event of increased muscle tightness in the shoulder and neck area due to increased requirements caused by walking on crutches.
- Electrotherapy: resorption-promoting currents, detonizing currents, high voltage (**Cave:** Metal implant).
- Compression bandage.
- CTM: arterial leg zone, venous lymphatic vessel area of the extremity concerned.
- Application of heat:
  - On hypertonic muscles
  - Reflective in accordance with traditional Chinese medicine (TCM): discharging the energy blockage via the diagonally related joint:
    - Right shoulder → left hip
    - Left elbow → right knee
    - Right foot → left hand
    - Abdomen → back.
- Use of the CPM from the first day post-op (approx. six hours/day).

7.2 Phase II

Goals (in accordance with ICF)

Goals of phase II (in accordance with ICF)

- **Physiological function/bodily structure:**
  - **Promoting resorption**
  - **Avoiding functional and structural damage**
  - **Regulation of impaired vegetative and neuromuscular functions**
  - **Improving joint mobility**
  - Improvement in functions affecting sensorimotor function
  - Pain relief
  - Improving muscular strength
  - Restoring the physiological movement pattern while walking
- **Activities/participation:**
  - Developing dynamic stability when walking, while observing load guidelines
  - Optimization of the support function, core and pelvic stability in movement
  - Independence when meeting the challenges of daily routines
  - Exploiting the limits of movement and load
  - Learning a home training program

7.2.1 Physiotherapy

Patient education

- Discussing the content and goals of treatment with the patient.
- Providing the patient with explanations regarding the limitations associated with the operation:
  - **Endoprosthetics:**
    No sitting with crossed legs
    No deep sitting for six weeks
    No adduction or external rotation for at least six months, lateral position therefore only with cushion/blanket between the legs initially
    No flexion in combination with adduction for at least three months
  - **Transposition osteotomies:**
    No long lever, i.e., no extended leg elevation for six weeks
    No deep sitting in the case of triple pelvic osteotomy
    None rotations with fixed foot in the case of corrective femur osteotomies
    Holding the leg in neutral rotation position
    When turning from supine position to lateral position, a cushion/cover should always be placed between the legs to prevent the minor gluteal muscles being active against gravity force and the leg must be held steady
    Handling the orthosis in the case of triple pelvic osteotomies (Newport orthotic extension/flexion 0°/20°/20° for six weeks).
  - **Labrum/femoral neck therapy:**
    No long lever for a total of six weeks
    No hyperextension for a total of six weeks
    No sitting with crossed legs in 90° hip flexion
    None rotations with fixed foot
    No flexion above 90° allowed, nor are combination movements from flexion, adduction, internal rotation.
- Learning movement transitions through joint-stabilizing muscle tension:
  - Standing up and lying down via the side that underwent surgery
  - To prevent long levers: With the foot that did not undergo surgery, the leg that was operated on is raised from dorsal position on the lower leg and used as a "crane" to reduce the weight.

Prophylaxis

- Active terminal movement in the ankle joints at second intervals.
- Active movement of the upper extremity.
- Everyday activities.
- Controlling the thrombosis pressure pain points upon the onset of pain, increase in swelling and rise in temperature in the relevant areas.

Promoting resorption

- Elevation.
- Active decongestion exercises.
- Manual lymph drainage.
- Smooth suction massage with suction cup along the lymphatic pathways to relieve congestion.
- Isometric tension of the lower extremity.

Improving mobility

- Axial passive/assistive movement in all directions of movement in prone, supine and lateral position.
  Cave: No lifting/shearing load in the case of transposition osteotomies.
- Counter-bearing mobilization in accordance with Klein-Vogelbach.
- Pelvic-leg suspension in sling table for low-lift mobilization, but not in the case of triple pelvic osteotomies.
- Improving mobility in the hip joint through the proximal lever with movement patterns from the PNF concept:

- Starting in lateral position (**Cave:** Triple pelvic osteotomy): to improve the flexion and internal rotation of pelvic patterns in posterior depression (with a cover between the legs to prevent adduction of the hip joint)
- Starting in lateral position: exercising of the pelvic pattern to improve extension, anterior elevation
- Introduce movement of the hip joint above the lumbar spine: on frontal level for abduction or on sagittal level for extension and flexion
- Starting in supine position: to improve internal rotation, arrange contralateral leg and press into bed with dorsal contact on the pelvis
- Starting in supine position: for an external rotation in the ipsilateral hip joint, apply contact to the contralateral SIAS and instruct the patient to tense against guided contact.

No resistance when performing pelvic patterns in the case of triple pelvic osteotomies!

Leave the area of the tensor fasciae latae muscle and vastus lateralis muscle – both are detached or split and refixed during the surgical access in the case of transition osteotomies.

- Soft tissue treatment:
  - Treatment of neighboring muscles: Ischiocrural muscles (**Cave:** In the event of triple osteotomies due to the approach on the ischial tuberosity), psoas muscle, iliac muscle, quadriceps femoris muscle (particularly affected by detachment during surgical access in the case of labrum/femoral neck therapy), adductor group, pelvic trochanter muscles (primarily piriformis muscle), gluteal muscles, quadratus lumborum muscle, pelvic floor muscles with the following techniques:
    - Integrated neuromuscular inhibition techniques (INIT)
    - Strain-counterstrain
    - Muscle energy technique (MET)
    - Functional massage
    - Relaxation techniques from the PNF concept.
  - Subsequently, potential stretching of the shortened structures (hold stretch position for at least one minute)
  - Treating ligament structures through cross-fiber massage: Iliolumbar ligament (Fig. 7.6), dorsal sacroiliac ligament, inguinal ligament, sacrotuberous ligament, sacrospinal ligament, obturator membrane
  - Treatment of the fascia via release techniques: Ischiatic fascia on upper leg and lower leg, fascia lata, iliac fascia, gluteal fascia (Fig. 7.7a), plantar fascia (Fig. 7.7b)

Fig. 7.6 Treatment of the iliolumbar ligament through cross-fiber massage

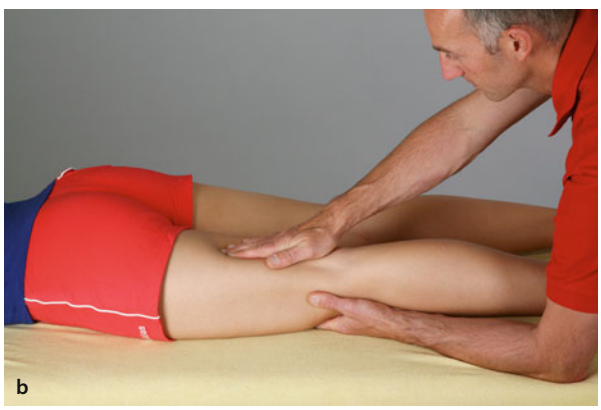

Fig. 7.7a,b Treatment of the fascia via release techniques. **a** Gluteal fascia, **b** Plantar fascia

Fig. 7.8a–d Normal slump

- Treatment of myofascial structures: superficial back and front lines, spiral line and lateral line.
- Mobilization of the neighboring joints: pelvis, sacroiliac joint, lumbar spine, thoracolumbar transition, sacrum, knee and foot depending on findings.

Restricted flexion in the knee joint often arises as a result of hypertonic vastus lateralis muscle (indentation during surgery): in this case, the mobilization of hip flexion is gentler when there is greater extension in the knee joint.

- Checking the cause-effect chain, for examples see ► Section 7.3.1.
- Independent mobilization with simultaneous leg axis training via wall slides.

Regulation of neuromuscular and vegetative functions

- Treatment in the orthosympathetic and parasympathetic areas of origin: Th8–L2 and S2–S4 through manual therapy, hot rolls, electrotherapy.
- Vegetative slump: spine flexion + spine lateral flexion + cervical spine lateral flexion and extension (example images display the typical slump (Fig. 7.8).
- Treatment of neurolymphatic and neurovascular reflex points (NLR/NVP):

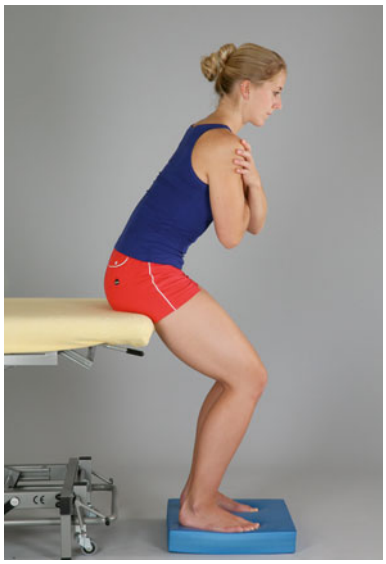

Fig. 7.9 Increasing sensorimotor exercises, e.g. on a balance pad

- Tibialis anterior and posterior muscles.
- Gluteus maximus and medius muscles
- Rectus femoris muscle
- Ischiocrural muscles
- Sartorius muscle
- Tensor fasciae latae (TFL)
- Popliteus muscle.

Improving sensorimotor function

- Angle reproduction on isokinetics or with the laser pointer.
- Proprioception training, e.g. placing.
- Increasing (closed chain) sensomotoric exercises (Fig. 7.9).
- Electrical muscle stimulation (EMS): visible muscle contraction.
- Perception training of the pelvis, the spine and the entire posture, e.g., Tai Chi, 'perpendicular heel' exercise.
- Exploiting the overflow in gait pattern through PNF:
  - For supporting leg activity on the side that underwent surgery:
    Leg pattern flexion adduction ER contralaterally
    Pelvic pattern of posterior depression in lateral position (side that underwent surgery above)
    Ipsilateral foot pattern in plantar flexion/pronation
    Ipsilateral arm pattern: Flex-add-ER
    Foot pattern plantar flexion pronation ipsilaterally
    Ulnar thrust ipsilaterally (Fig. 7.10).
  - For swing leg activity on the side that underwent surgery:
    Leg pattern extension abduction IR contralaterally
    Foot pattern in DE-supination-inversion for further flexion-adduction-ER

Fig. 7.10 Exploiting the overflow in gait pattern through PNF for supporting leg activity on the side that underwent surgery: ulnar thrust ipsilaterally

    Pelvic pattern in anterior elevation in lateral position (side that underwent surgery on top)
    Foot patterns DE/SUP for in flexion-addution-ER or DE/Pro for Flexion-abduction-IR (symmetrically or reciprocally) ipsilaterally
    Ipsilateral arm pattern in extension-abduction-IR
  - In the event of triple pelvic osteotomies:
    Foot pattern on leg that underwent surgery, e.g., reciprocal plantar flexion/pronation and contralateral dorsal extension/supination

Stabilization and strengthening

- Leg axis training in low-load starting positions such as supine position, sitting sideways, between parallel bars or equipment-supported (Fig. 7.11).
- Muscle training: spine-stabilizing muscles, pelvic muscles, pelvic floor muscles, abdominal muscles (**Cave:** Careful training of the oblique stomach muscles in the case of triple pelvic osteotomies), small gluteal musculature and shoulder girdle.

Patients with hip joint problems frequently also suffer from incontinence. The activation of the "internal corset" (transverse abdominal muscle, multifidus muscles, diaphragm and pelvic floor) is to be integrated into the treatment! Observe visceral connections in findings.

- Strengthening the lower leg and foot muscles: Foot screw (Spiraldynamik).
- Bridging with endoprosthetic.
- Step-ups.
- Careful training of the "assumedly not affected" contralateral side (low load, joint-protecting exercises to prevent pre-arthritis).
- Local and general stabilization exercises of the spine (▶ Section 19.2.1).

Fig. 7.11 Equipment-supported leg axis training in low-load starting positions

Fig. 7.12 Training with three-point or four-point gait depending on the load guidelines, on the step with the leg that underwent surgery with step-to-step technique

- Training the shoulder-arm muscles in terms of support activity.
- Exercise pool (requirement: medical approval following inspection of the sound and pain situation).
- Transfer exercises (e.g. supine position → sitting → standing via the side that **underwent surgery**).
- Stabilization of the foot (longitudinal and transverse arches, heel bone).

Gait

- Training with three-point or four-point gait depending on the load guidelines, on the step with step-to-step technique (Fig. 7.12).

Practical tip

Developing gait

- The walking cycle is divided into sequences, and the individual movement components are performed in isolation.
  - Example: stabilization of the pelvis under load while standing/standing on one leg. Then dynamically as a step: the patient exercises pelvic stabilization using parallel bars; ankle joint and forefoot rocking in supporting leg phase while simultaneously practicing the swing leg phase of the contralateral leg.
- The sequence is then integrated into the overall movement process.
  - In the example: exercising the entire standing leg phase of the walking cycle.

- Exercising with step combinations with the correct timing, e.g. side-steps on parallel bars (simultaneously training the abductors) (Fig. 7.13).
- Leg axis training: Learning three-point foot weight-bearing as a basis for the leg axis, with static core involvement: the pressure-bearing points of the foot are supported on wooden blocks. The patient should firstly perceive the pressure points and then build up the arch of the foot.
  Leg axis training with relaxation or permitted load in supine position, sitting, half-standing position.

Pathology of medial collapse

- Collapse of the longitudinal arch
- Medial rotation of the tibia and caudal tipping
- Medial rotation of the femoral condyles in the knee joint
- Adduction/external rotation or abduction of the pelvis
- Lateral flexion to the opposite side in the lumbar spine

- Training the supporting leg phase in walking function, e.g., on parallel bars controlling pelvic stability from terminal standing to the mid-swing phase.
- Training the rolling phase.
- Training getting into and out of the therapy car.
- Walking through a garden to vary the ground surface.
- Load control on the force measurement plate.
- Controlling leg length.

Fig. 7.13a–e Exercising with step combinations with the correct timing: side-steps on parallel bars (simultaneous training of the abductors). **a** Shifting weight to the contralateral side, non-supporting leg is free, **b** Shifting weight with the pelvis horizontally above the free leg, right leg begins free leg phase, **c,d** Bearing weight on the right side as supporting leg, left leg as free leg, **e** Bipedal standing position

Physical measures

- Manual lymph drainage/lymph taping.
- Partial massage: Should the unaffected leg be overburdened or in the event of increased muscle tightness in the shoulder and neck area due to increased requirements caused by walking on crutches.
- Electrotherapy: resorption-promoting currents, detonizing currents, high voltage (**Cave:** Metal implant).
- Compression bandage.
- CTM: arterial leg zone, venous lymphatic vessel area of the extremity concerned.
- Foot reflexology massage:
  - Symptom zones and vegetative zones
  - Drink enough water
  - Don't forget balancing grips.
- Application of heat:
  - On hypertonic muscles
  - Reflective in accordance with traditional Chinese medicine (TCM): discharging the energy blockage via the diagonally related joint:
    - Right shoulder → left hip
    - Left elbow → right knee

  - Right foot → left hand
  - Abdomen → back
- CPM (Continuous Passive Motion) splint: six hours per day with repeated applications.

- **Inspecting and adjusting the aids (crutches, orthosis)**
- **All exercises only within the pain-free range**
- **Holding in a pain-free (or low pain) position: where possible with hip and knee joints in neutral position**
- **Only use crutches under full weight-bearing if the pelvis has good stability: no Duchenne or Trendelenburg limp should be visible anymore!**

7.2.2 Medical training therapy

- General accompanying training of the core and the upper extremity: hoist, dip trainer, rowing, butterfly reverse, bench presses.

Endurance training

- Three-point ergometer without the use of the extremity concerned, insofar as maximum load-bearing is not reached.
- Ergometer training/load 1 × 10 up to 2 × 15 mins with low load at 20–50W, potentially with shortened crank.
- Walking training, controlling weight loads while walking on a force measurement plate.

Sensorimotor function training

- Working out the leg axis within the permitted load and range of motion:
  - Mini squats on both legs up to max. 60° flexion in the knee joint, potentially also while stepping forward. Perform both exercises with closed eyes
  - Putting down foot in standing position or sitting on a balloon. Perform PNF diagonal patterns over the upper extremity on the cable pulley
  - Pilates reformer training in the form of leg presses with 10-15kg weight.
- Developing standing stabilization (level surface, later also unstable/stable):
  - Bearing weight on both legs while standing in parallel
  - Bearing weight while stepping forwards
  - Also guiding the thigh via a cable pulley
  - Developing the stabilization of the foot arch on block.

Fig. 7.14 Training hip joint stabilizers: hip extension on the angle table with upper body resting

Strength training

- Intramuscular activation via isometry.
- Strength endurance training of the muscles of the lower extremity, adapted to plan; additional focus of local stabilizers of transverse abdominal muscle, multifidus muscles, pelvic floor, 4 x 30 reps within completely pain-free range.
- Overflow via the contralateral side (strength endurance training; 4 x 20 reps) in extension and abduction.
- Training the lumbar spine extensors on an angle table or a bench: upper body lies on the bench, standing on both feet, move lumbar spine into extension and hold.
- Training hip joint stabilizers:
  - Flexion/extension (slides in supine position; leg lifts in prone position on bench)
  - Abduction/adduction (sliding on slideboard/tile, in lateral position)
  - Hip extension on the angle table with upper body resting (Fig. 7.14)
  - Squats with reduced weight
  - Rotation (rotation disc, between 10 and 11 o'clock left/1 o'clock and 2 o'clock right, without load, stable pelvis (**Cave:** Surgical access).
- Redcord® system: Pelvic-leg suspension
  - Training in direction of lumbar spine pelvic stabilization and abductor training.
- Training ankle joint stabilizers:
  - Plantar flexion (Vitality® band)
  - Dorsal extension (Vitality® band)
- Isokinetics: angle reproduction, CPM mode.
  - Training standing stabilization via stimuli to the upper body.

7.3 Phase III

Goals (in accordance with ICF)

Goals of phase III (in accordance with ICF)

- **Physiological function/bodily structure:**
  - **Improving joint mobility**
  - **Optimization of core and pelvic stability**
  - **Restoration of muscular strength**
  - **Restoration of dynamic joint stability**
  - Optimization of functions affecting sensorimotor function
  - Optimization of a coordinated movement pattern along the kinematic chain during movement
  - Optimization of the gliding ability of neural structures
- **Activities/participation:**
  - Developing ergonomic posture and movements in everyday routine, at work, during sport
  - Resumption of professional activities
  - Active participation in the life of the community/family life

7.3.1 Physiotherapy

Patient education

- Discussing the content and goals of treatment with the patient.
  - **Endoprosthetics:** Weaning off crutches with sufficient pelvic stability, i.e., no Duchenne or Trendelenburg limp should be visible anymore!
- Informing the patient about the restrictions they will still have.
  - **Transposition osteotomies:** Weaning off forearm crutches in the case of corrective femur osteotomies, increasing load in the case of triple pelvic osteotomies following radiological controls with 15kg per week.
- Ergonomic advice for everyday and working life and sport.
- Begin with gentle sporting activities such as swimming (crawl) and cycling:
  - Transposition osteotomies from approx. 4 months post-op.
  - Labrum/femoral neck treatment from approx. 7 weeks post-op.

Improving mobility

- Precise instructions for independent mobilization and stretches in the case of existing restrictions in movement.

Fig. 7.15 Treatment of neighboring muscles: Quadratus lumborum muscle

- Manual mobilization of the hip joint: The dorsal capsules may stick together due to the initial limitation of flexion.
- Soft tissue treatment:
  - Treatment of neighboring muscles: ischiocrural muscles, psoas muscle, iliac muscle, quadriceps femoris muscle, adductor group, pelvic trochanter muscles (primarily piriformis muscle), gluteal muscles, quadratus lumborum muscle (Fig. 7.15), pelvic floor muscles through:
    - INIT
    - Strain-counterstrain
    - MET
    - Functional massage
    - Relaxation techniques from the PNF concept
  - Subsequently, potential stretching of the shortened structures (hold stretch position for at least one minute)
  - Treating ligament structures through cross-fiber massage: Iliolumbar ligament, dorsal sacroiliac ligament, inguinal ligament, sacrotuberous ligament, sacrospinal ligament, obturator membrane (Fig. 7.16)

Fig. 7.16 Treating ligament structures through cross-fiber massage: obturator membrane

Fig. 7.17 Treatment of the myofascial structures: superficial back line

- Treatment of the fascia via pressure and release techniques: ischiatic fascia on upper leg and lower leg, fascia lata, iliac fascia, gluteal fascia, plantar fascia
- Treatment of the myofascial structures: superficial back and front lines, spiral line and lateral line (Fig. 7.17).

- Mobilization of the neighboring joints: pelvis, sacroiliac joint, lumbar spine, knee and foot depending on findings.
  - Controlling pelvic position for e.g. ilium misalignments (inflate and outflare, rotations etc.)
  - Analyzing the chain of cause and effect: See examples in the following overview.

Descending chain of cause and effect: Examples

- Primary lesion is an ilium rotation in anterior direction + outflare
  - L4/L5 rotation through traction of iliolumbar ligament homolaterally
  - Stretching the semitendinosus and semimembranosus muscles (knee joint function: flexion/IR)

  Thereby influence on:
  - Pes anserinus (e.g. tendonitis)
  - Medial meniscus (dorsal fixation)
  - Dorsal capsule tension
  - Stretching the biceps femoris muscle (function knee joint: flext/ER)

  Thereby influence on:
  - Fibular (translated cranially/plantar flexion restriction)
  - Peroneal nerve
  - Site of the emergence of the interosseous membrane bundle of vessels and nerves

  (circulation problems in thigh and foot, paresthesia over the course of the common peroneal nerve)
  - Stretching the peroneus longus muscle (IR of cuboid bone)
  - Stretching tibialis posterior muscle (ER of navicular bone)
- Anterior ilium bone leads to an IR position of the hips (IR of the entire lower extremity; talus bone tilts medially; more load placed on inside of the foot)
- Problems when sitting and through ilium outflare fixation
- Ilium-anterior fixation through hypertonic iliacus muscle = involvement of pelvic organs.

- Primary lesion is an ilium rotation in posterior direction + inflate:
  - Stretching sartorius muscle (function knee sliding joint: flexion/IR)

    Thereby influence on:
    - Pes anserinus
  - Stretching tensor fasciae latae muscle (pain on lateral knee side)
  - Stretching rectus femoris muscle (influence on tibial tuberosity; patella ligaments; increase in contact pressure in the femuropatella joint
  - Posterior ilium bone leads to an ER position of the hips; talus bone tilts laterally; more load placed on outside of the foot.

- Independent mobilization with simultaneous leg axis training via wall slides.
- Pelvic pattern in lateral position.
- Mobilization of neural structures:
  - Prone knee bend
  - Straight leg raise
  - Slump for obturator nerve (slump + hip abduction).

Regulation of vegetative and neuromuscular functions

- Depending on findings: See phase II.

Improving sensorimotor function

- Leg axis training in load-intensive start positions (Fig. 7.18).
- Intensification of training to improve perception, adapted to potential new strains, e.g., walking on different surfaces with visual and acoustic distractions, walking through a garden/course while holding a conversation, opening an umbrella, singing, different lighting.

Fig. 7.18a,b Leg axis training in load-intensive starting positions **a** Standing on one leg with unstable support surface, **b** With additional tasks

- Perception training of controlled pelvic movement, e.g., via the pelvic swing exercise (eccentric dropping of the iliopsoas muscle).
- Proprioception training on different unstable surfaces, beginning with change of rhythm (Fig. 7.19).
- Balance training on different unstable surfaces, beginning with change of rhythm (Fig. 7.20).
- Reaction and braking test in therapy car.
  - It is possible to apply 200N of pressure to the brake pedal? This is required for coming to a full stop.
- Tai Chi, e.g. bear stance (Fig. 7.21).

Stabilization and strengthening

- Dynamic workout on different surfaces (mat training) and partial load on ball cushion, MFT, balance board, stabilization pads or trampoline.
- Lunges (Fig. 7.22).
- Developing dynamic stability in supporting and free leg phase, beginning with parallel bars.
- Lunges forwards (in the case of corrective femur osteotomies).
- Step-ups und downs.
- Bridging and variants (Fig. 7.23).

Fig. 7.19a,b Proprioception training on different unstable surfaces in step combinations

Fig. 7.20a–c Balance training on different unstable surfaces, beginning with change of rhythm

Fig. 7.21 Tai Chi: Bear stance

Fig. 7.22 Lunges

Fig. 7.23 Bridging and variants

Fig. 7.24 Gyrotonic

- Begin with distal resistance on leg that underwent surgery:
  - Beginning exercises on the Vitality® band, traction apparatus, leg press/shuttle etc. on the extremity that underwent surgery, with a focus on the hip and pelvis-stabilizing muscles
  - PNF with proximal and distal resistance (**Cave**: Still no adduction, rotation and flexion above 90°!)
  - Developing dynamic stability in supporting and free leg phase, beginning with parallel bars.

Patients with hip joint problems often suffer from weakness in the deep abdominal muscles as well as insufficient activation of the "internal corset" (transverse abdominal muscle, multifidus muscles, pelvic floor and diaphragm) (see also ► Section 19.2.1).

- Exercise pool:
  - Increased step combinations
  - Use of buoyancy aids
  - Aqua jogging
  - Crawl leg kick.
- Gyrotonic (Fig. 7.24).
- Isokinetics (stabilization training while standing).
- Rectifying muscular deficits through supporting leg training (especially gluteal muscles) in vertical starting positions.
- Functional training with the Redcord® system for the entire leg and core muscles.
- Pilates side-lying leg lift.

Gait

- Weaning off crutches where full load is allowed.
- Reaction and braking test in therapy car.
- See also ► Section 'Improving sensorimotor function'.

Requirements for walking without crutches

- Walking is possible without evasive movements
- Dynamic stabilization ability of the pelvis (e.g. no Trendelenburg's sign) achieved
- Pain-free walking (e.g. without Duchenne limp) is possible
- Even leg length

- Perfecting of gait: rectifying Trendelenburg's sign/ Duchenne limp, controlling track width, rhythm and stride length.
- Combination of steps with the use of visual (mirror, floor markings) and acoustic (rhythmic tapping) aids.
- Economization of gait (step length, track width, rhythm).
- Increasing the simulation of everyday strains (e.g. walking in the walking garden with additional tasks, Fig. 7.25).
- Increasing the exercise duration on the treadmill while checking in mirror.
- Video gait analysis as feedback for the patient.
- Walking on the force measurement plate for load control. Is the load borne on the side that was operated on?

Physical measures

- Foot reflexology. Then drink plenty of water.
- Connective tissue massage (small structure).
- Electrotherapy (**Cave:** High voltage therapy in the case of metal implants).
- Traditional massages: thoracic spine, lumbar spine, pelvis, lower extremity.
- Acupuncture massage for the energetic treatment of the scar.

Fig. 7.25 Increasing the simulation of everyday strains, e.g.: walking in the walking garden with additional tasks

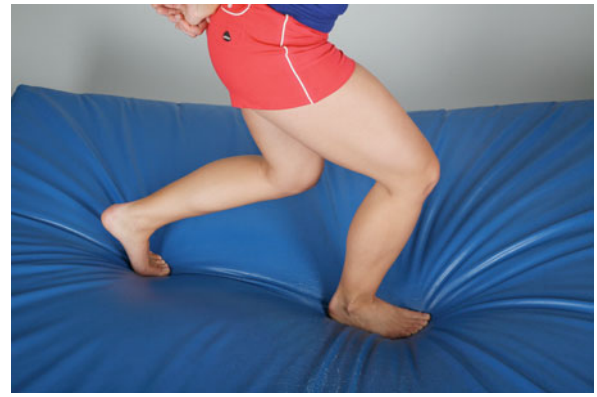

Fig. 7.26 Feedback training on the mat

7.3.2 Medical training therapy

Endurance training

- Ergometer training 20–30 mins with increasing duration and wattage depending on physical condition.
- Treadmill exercise: 10–20 mins uphill walking (3-4km/h) with 10% incline.

Sensorimotor function training

- Developing the stabilization of the leg axis under variable conditions, including with medium loads:
  - Standing stabilization on an instable surface with cable pulley weight laterally on the leg
  - Standing on tilt board and rotation training for the upper body on the cable pulley.
- Single-leg standing exercises under variable conditions:
  - Single-leg load bearing (e.g., step combination at higher speed)
  - Developing foot stabilization and dynamic movement (e.g. spiral dynamic screw connection of the foot).
  - Load distribution training of the foot in dynamic situations, e.g. side step.
- Developing walking alphabet:
  - Step combinations from standing
  - Ankle workout while standing (e.g., rolling from toes to heel)
  - Running on forefoot with small amplitude, slowly forwards.
- Feedback training, also with medium loads: e.g., single-leg squats on proprio-swing system, balance board, Posturomed. Also in conjunction with XCO or Bodyblade, mat (Fig. 7.26).
- Sport-specific conditioning: e.g., side-step tennis.

Strength training

- General accompanying training of the core and the upper extremity.
- Endurance strength training, as warmup exercise for the local stabilizers, see phase II.
- Hypertrophy for general musculature with medium range of motion: 6 × 15 reps, 18/15/12/12/ 15/18; as pyramid, training only within the completely pain-free range:
  - Squats (dead lift, squats with various upper body flexion, squat lunges) (Fig. 7.27)
  - Step-ups
  - Abductor training (cable pulley)
  - Training the core and gluteal musculature (Good Morning, rowing)
  - Abductors in abducted and extended position
  - Hip extension and flexion on the cable pulley
  - Rotation within the permitted range of motion.
- Redcord® system: abductors and lateral core muscles, leg-pelvic training.
- Training eccentric muscle activity: e.g., low level step-downs.

Therapeutic climbing

- Initial stabilization from deep joint position in vertical wall area with traction support (Fig. 7.28).
- Approval of rotational starting pattern.
- Step alternating training in the positive wall area, changing moves (up/down, side to side).

Fig. 7.27 Hypertrophy for general musculature

Fig. 7.28 Therapeutic climbing: Initial stabilization from deep joint position in vertical wall area with traction support

Isokinetics

- Standing stabilization through distraction stimuli to the upper body.

7.4 Phase IV

The objective of training in phase IV lies in the patient's ability to resume sporting activities. The sports-therapeutic content of rehabilitation phase IV following hip joint operations is summarized for the entire lower extremity in ▶ Section 15.4.

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Thigh: Surgical procedure/ aftercare

Andreas Imhoff, Knut Beitzel, Knut Stamer, Elke Klein

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8.1 Muscle/Tendon Repair

Indications for muscle/tendon repair are generally complete ruptures in the area of the insertion or origin of the thigh muscles.

8.1.1 Refixation of the ischiocrural muscles

Indication

- Rupture of the ischiocrural muscles

Surgical method

- Skin incision transversely on the lower edge of the gluteus muscle, longitudinal split of the ischiocrural fascia.
- Preparation of the point of original at the ischial tuberosity, while protecting the sciatic nerve.
- Extensive mobilization of the muscle group distally and suturing of the tendon stump.
- Placement of between two and three anchor sutures (e.g. Titan Corkscrew by Arthrex) in a bone groove in the area of origin of the bones and tension-free refixation of the tendon stump with non-resorbable sutures with the knee joint in flexion (Fig. 8.1).

Aftercare

Table 8.1 provides an overview of aftercare.

8.1.2 Refixation of the proximal rupture of the rectus femoris muscle

Indication

- Proximal rupture of the rectus femoris muscle.

Surgical method

- Ventral distal access to the anterior superior iliac spine with longitudinal skin incision between the tensor fasciae latae and sartorius muscles, blunt access between the tensor fasciae latae and sartorius muscles.
- Preparation of the area of origin in the area of the anterior inferior iliac spine.
- Extensive mobilization of the muscle (potentially distally) and suturing of the tendon stump.
- Placement of two and three anchor sutures (e.g., Titan Corkscrew or transosseous drill channels) in the area of origin and tension-free refixation of the tendon stump with non-resorbable sutures.
- Wound closure layer by layer.

Aftercare

Table 8.2 provides an overview of aftercare.

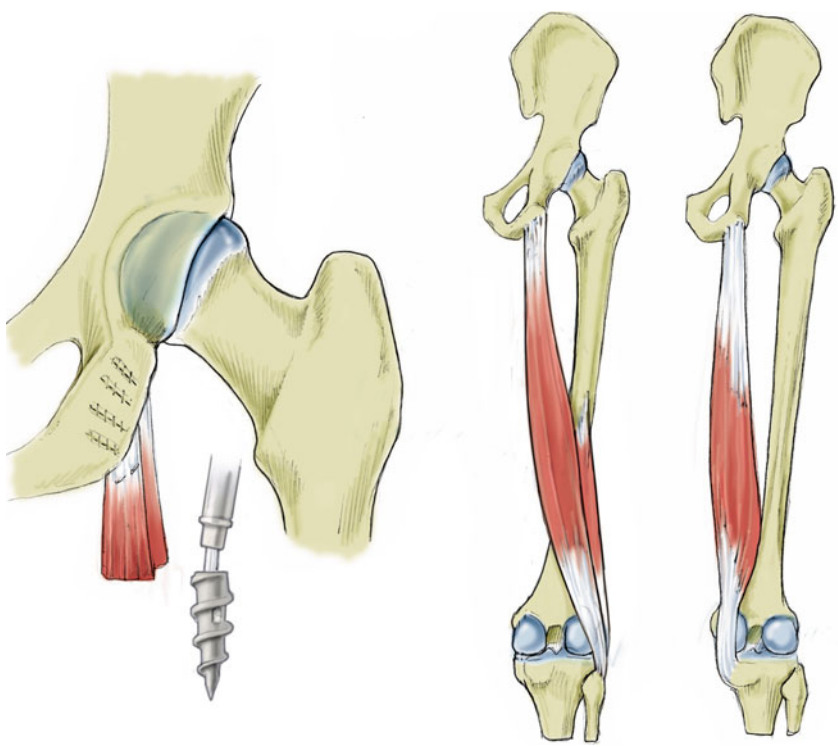

Fig. 8.1 Suture fixation for proximal ruptures of the ischiocrural muscle group

Table 8.1 Refixation of the ischiocrural muscles. Hip orthosis (Newport orthosis with knee involvement) for six weeks postoperatively (hip: flexion/extension: 0°/0°/0°; knee: flexion/extension: free/90°/0°)

Phase	Range of motion and permitted load	
I	from 1st day post-op:	Hip mobility: flexion/extension: 0°/0°/0° Knee: passive flexion/extension: free/90°/0° Pressure relief
II	from 7th week post-op:	Free active mobility Increase weight load by 20kg/week
III	approx. 12 weeks post-op:	Start of running training (even ground), cycling, swimming (crawl)
IV	approx. 6 months post-op:	Resumption of sport and sport-specific training
	approx. 8 months post-op:	Contact and high-risk sports (following consultation with a doctor)

Table 8.2 Refixation of the proximal rupture of the rectus femoris muscle. Hip orthosis (Newport orthosis) for six weeks post-op (hip: Flexion/extension: free/30°/0° (**Cave:** Placement of orthosis dependent upon intraoperative tension ratio!!)

Phase	Range of motion and permitted load	
I	from 1st day post-op:	Hip: flexion/extension: passive free/30°/0°(depending on intraoperative tension ratio! / no active flexion!) Pressure relief
II	from 7th week post-op:	Mobility: free Increase weight load by 20kg/week
III	from 12th week post-op:	Flexion against resistance permitted
	approx. 12 weeks post-op:	Start of running training (even ground), cycling, swimming (crawl)
IV	approx. 6 months post-op:	Resumption of sport and sport-specific training including contact and high-risk sports (following consultation with a doctor)

8.1.3 Refixation of the distal quadriceps rupture

Indication

- Distal quadriceps tendon rupture.

Surgical method

- Skin incision lengthways on the proximal patella.
- Preparation of the insertion area.
- Extensive mobilization of the muscle and suturing of the tendon stump.
- Placement of two and three anchor sutures (e.g., Titan Corkscrew) in a bone groove (or transosseous drill channels) and tension-free refixation of the tendon stump with non-resorbable sutures.
- Wound closure layer by layer.

Aftercare

Table 8.3 provides an overview of aftercare.

Table 8.3 Refixation of the distal quadriceps rupture. Knee joint extension splint (MEDIORTHO® Classic) for six weeks post-op (in the event of a complete rupture)

Phase	Range of motion and permitted load	
I	from 1st day post-op:	Flexion/extension: 30°/0°/free (depending on intraoperative tension ratio!!/no active extension!!) 20kg partial load in stretch position with splint!
II	from 7th week post-op:	In stretch position with splint permitted. Pain-adjusted increase in weight load by 20kg/week in the splint; mobility: free
III	from 12th week post-op:	Extension against resistance permitted
	approx. 12 weeks post-op:	Start of running training (even ground), cycling (click-in pedals three months post-op), swimming (crawl)
IV	approx. 6 months post-op:	Resumption of sport and sport-specific training including contact and high-risk sports (following consultation with a doctor)

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9.1 Phase I

Phase I of rehabilitation following thigh surgery corresponds to phase I following hip surgery (▶ Section 7.1).

9.2 Phase II

Goals (in accordance with ICF)

Goals of phase II (in accordance with ICF)

- **Physiological function/bodily structure:**
  - **Promoting resorption**
  - **Regulation of impaired vegetative and neuromuscular functions**
  - **Improving joint mobility**
  - Avoiding functional and structural damage
  - Improvement in functions affecting sensorimotor function
  - Strengthening non-impaired functions
  - Retaining the function of the physiological movement pattern while walking
  - Pain relief
- **Activities/participation:**
  - Developing muscular stability when walking, while observing load guidelines
  - Optimization of the support function, core and pelvic stability in movement
  - Independence when meeting the challenges of daily routines
  - Exploiting the limits of movement and load
  - Learning a home training program

9.2.1 Physiotherapy

Patient education

- Discussing the content and goals of treatment with the patient.
- Providing the patient with further information regarding the level of tissue healing, the resulting load-bearing capacity and the associated limitations:
  - No activity/strain on the repaired muscles
  - No sitting in the event of refixation of the ischiocrural muscles.
- Handling the Newport orthotic (■ Fig. 9.1).
- Controlling crutches (length, handling).
- Learning movement transitions without putting the refixed muscles at risk.

Improving mobility

- Passive movement in lateral position or supine position under diminished weight.
- Detonization of reactively hypertonic muscles.
- Mobilization of the lumbar spine and pelvic region.
- Fascia techniques on the pelvis and the lower extremity, e.g., long plantar ligament, fascia cruris, lateral thigh fasciae, ischiatic fascia on the thigh and lower leg, fascia lata.
- Activation of the antagonists to detonize the refixed muscle within the permitted range
  - **Refixation of the ischiocrural muscles:** Starting in lateral position with **full** extension in hip joint: The patient move under diminished weight in the knee joint in the direction of extension (flexion/extension 130°/30°/0°). The therapist then guides the leg passively into flexion (**Cave:** Only with full extension in the hip joint)
  - **Quadriceps refixation:** Starting in lateral position with 50° hip joint flexion: The patient may dynamically flex the knee joint at 30° concentrically under a diminished weight (muscle function value 2).

Regulation of vegetative and neuromuscular functions

- Treatment in the orthosympathetic and parasympathetic areas of origin: manual therapy, hot rolls, electrotherapy, oscillations in the corresponding segments.

■ **Fig. 9.1** Newport orthotic

Gait

- Controlling the length of crutches.
- Strengthening the support muscles:
  - Exercising the scapulae in posterior depression, statically and dynamically
  - Strengthening the arms in support pattern extension-abduction-ER
  - Independent exercises with Vitality® band or trowel.
- Walking securely on crutches on flat surfaces and on stairs.
- Inspecting the Newport orthotic while standing/walking.

Endurance training

- Gait training.

Sensorimotor function training

- Working out the leg axis within the permitted load and range of motion in half-seated position or standing, e.g., under pressure relief on the cable pulley.
- Developing standing stabilization (level surface, later also unstable/stable) depending on load plans and range of motion:
  - Bearing weight on both legs while standing in parallel
  - Bearing weight while stepping forwards.

Strength training

- Intramuscular activation via isometry.
- Overflow via the contralateral side (strength endurance training; 4 x 20 reps) using cable pulley starting in supine position: PNF leg pattern, adduction-abduction
- Training knee joint stabilizers:
  - Flexion (Vitality® band slides while sitting from extension with tile under the heel) within permitted ranges of motion.
- Training ankle joint stabilizers:
  - Plantar flexion (Vitality® band)
  - Dorsal extension (Vitality® band).

9.3 Phase III

Goals (in accordance with ICF)

Goals of phase III (in accordance with ICF)

- **Physiological function/bodily structure:**
  - **Improving joint mobility**
  - **Improvement in functions affecting sensorimotor function**
  - **Optimization of core and pelvic stability**
  - **Restoration of muscular strength**
  - **Optimization of a coordinated movement pattern along the kinematic chain during movement**
  - Optimization of the gliding ability of neural structures

Activities/participation:

- Developing ergonomic posture and movements in everyday routine, at work, during sport
- Resumption of professional activities
- Active participation in the life of the community/family life

9.3.1 Physiotherapy

Patient education

- Discussing the content and goals of treatment with the patient.
- Informing the patient about applicable guidelines:
  - Free mobility
  - Extension against resistance in the event of proximal rectus refixation only allowed from the 12th week
  - Extension against resistance in the event of refixation of the ischiocrural muscles only allowed from the 12th week
  - Extension against resistance in the event of the rupture of the quadriceps tendon only allowed from the 12th week.

Improving mobility

- Active movement beginning with short levers (in lateral position in the case of biceps and quadriceps femoris refixations).
- Potentially patella mobilization in all four directions.
- Treatment of patella misalignments.
- Mobilization of the lumbar spine/pelvic region, primarily ilium misalignments (rotations).
- Soft tissue treatment on the pelvis and lower extremity:
  - Ligament via cross-fiber massage: Sacrotuberous ligament, sacrospinal ligament, iliolumbar ligament, patella ligament, suprapatellar recess
  - Muscles: Adductor muscles, quadriceps femoris muscle, ischiocrural muscles, iliacus muscle, psoas muscle through:
    - Integrated neuromuscular inhibition techniques (INIT)
    - Strain-counterstrain
    - Muscle energy technique (MET)
    - Functional massage

  Subsequently, potential stretching of the shortened structures (hold stretch position for at least one minute)

- Fasciae via pressure and release techniques: long plantar ligament, fascia cruris, lateral thigh fasciae, ischiatic fascia on the thigh and lower leg, fascia lata.
- Mobilization of neural structures through the following techniques: straight leg raise (SLR) or prone knee bend (PKB) via slider or tensioner techniques.
- Checking the cause-effect chain (▶ Section 7.3.1).

Regulation of vegetative and neuromuscular functions

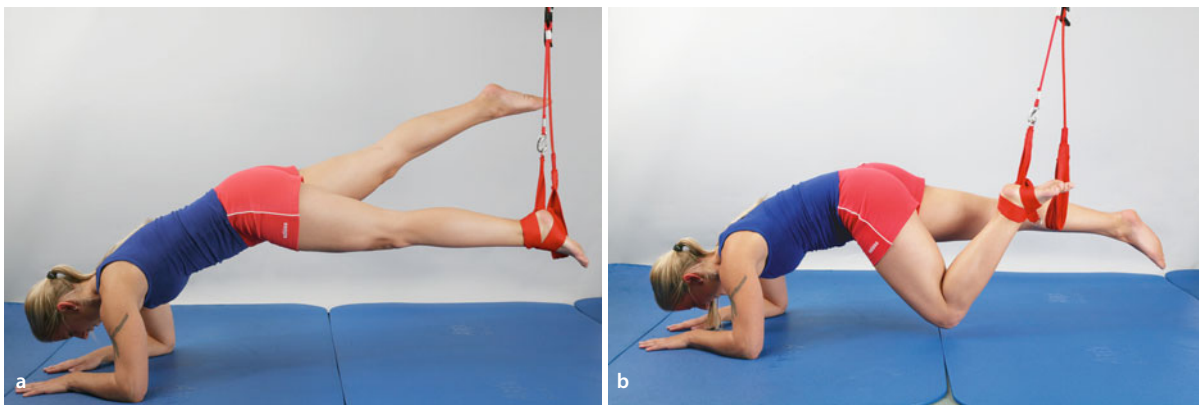
- Treatment of tender points:
  - Strain-counterstrain technique: Apply pressure to the point of pain or to the most hardened area of the muscle. Relaxation of the tissue by moving the neighboring joints until the pain subsides or the tissue has noticeably relaxed. Hold this position for 90 seconds and then passively (!) return to the starting position.
- Treatment of trigger points:
  - INIT: Apply ischemic compression to the trigger point through pressure, until the pain lessens. Should no change in the pain occur after 30 seconds, relieve compression and apply a positional release technique, i.e., convergence of structures until release. Then seven seconds of isometric tensing and stretching of the muscle.

Improving sensorimotor function

- Exercising on both legs on stable then later on unstable support surfaces, e.g., tilt board, balance board, ball cushion.
- Beginning with step combinations, then later beginning with one-legged stabilization exercises,
  - With eyes open
  - Looking away
  - With eyes closed.
- Beginning closed system isokinetics to improve intramuscular coordination (alternatively shuttle).
- Developing weight-bearing while standing and moving forwards.
- Stabilization training on the mat.
- Isometry.

Stabilization and strengthening

- Start of stabilization training:
  - Isometry
  - "Knee circles": from lateral position (adduction, abduction in hip joint/prone position extension (glutes)
  - Leg axis training: e.g., squats, wall slides
  - Begin with dynamically concentric movement (muscle function value 2) under diminished weight. Should the patient be able to perform the exercises pain-free and without evasive movements, a transition can be made to training the repaired muscles up to muscle function value 3 (against gravity)
  - Training vastus medialis muscle: closed chain for extension/open chain for flexion
  - Exercise with the Redcord® system to exercise the muscular chains (◘ Fig. 9.2)
  - Knee-bends: developing from 60:40 (injured/healthy) 20–60° to 50:50 with additional weight
  - Strengthening the muscle chains of the lower extremity: gluteus maximus muscle on the right and latissimus dorsi muscle on the left
  - Dynamic stabilization with increased load
  - Intensive foot muscle and lower leg strengthening
  - Walking on the spot against cable pulley (◘ Fig. 9.3), Vitality® band (or life-line) stabilization exercises on the tension apparatus (injured leg on twist board, trampoline)
  - Exercise pool: beginning with aqua jogging, coordination and stabilization exercises.
- Strengthening the core muscles.



◘ **Fig. 9.2a,b** Training with the Redcord® system to exercise the muscular chains

Fig. 9.3a,b Leg axis training dynamically and statically with the cable pulley

- Strengthening the remaining hip and leg muscles:
  - Hip abductors: standing sideways on the step, extended leg. Pelvic abduction strongly on frontal level: strengthening the small gluteal muscles contralaterally (pelvic drop)
  - Calf muscles: standing on tiptoes
  - Peroneal muscles: penguin crunches from the functional kinetics concept
  - Quadriceps muscle: bipedal standing with back to the wall, set knee flexion at 100° (ratio 60:40) and then by moving the ankle joints into tiptoe position while maintaining the knee joint flexion.
- Cycle ergometer, beginning with 50-75 watts.
- Stepper.

Gait

- Practicing the gradual development of load until full load, controlling the bearing of weight by walking on force measurement plates.
- Weaning off crutches: beginning on parallel bars.

Requirements for walking without crutches

- Gait without evasive movements (e.g., medial collapse)
- Stabilization of the pelvis (e.g., no Trendelenburg gait)
- Pain-free walking (e.g., without Duchenne limp)
- Even leg length
- Under force value 4 of the hip joint-stabilizing muscles, dynamic stabilization ability is possible in the vertical plane

- Perfecting of gait: rectifying Trendelenburg's sign/Duchenne limp, controlling track width, rhythm and stride length.
- Leg axis training firstly under partial load and visual control in front of the mirror, e.g., half-sitting on the bench:
  - Develop three-point weight-bearing on the foot
  - Positioning the knee joint to prevent medial collapse
  - Correction of the hip joint in front, sagittal and transverse level
  - Neutral position of the lumbar spine
  - Independent exercises: wall slides in supine position with feet against the wall, wiping movement while sitting; foot on slippery towel, providing mobilization into flexion and extension.
- Combination of steps with the use of visual (mirror, floor markings) and acoustic (rhythmic tapping) aids.
- Increasing the simulation of everyday strains, e.g., walking in the walking garden with additional tasks:
  - Various surfaces
  - ± Obstacles
  - ± Noise/sounds
  - ± Additional tasks.
- Increasing time on the treadmill while checking in mirror.
- Video gait analysis as feedback for the patient.

Physical measures

- Massage of the structures near the joints and associated muscle loops.
- Functional massage.

- Reflexology (Marnitz therapy, periosteal massage, connective tissue massage).
- Hot rolls.
- Electrotherapy: high voltage.
- Acupuncture massage for the energetic treatment of the scar.

9.3.2 Medical training therapy

- General accompanying training of the core and the upper extremity.
- Walking training, weaning off crutches.

Sensorimotor function training

- Developing the stabilization of the leg axis under variable conditions, including with medium loads (e.g. standing stabilization on instable surface with lateral cable pulley load).
- Single-leg standing exercises under variable conditions:
  - Single-leg load bearing (e.g., step combination at higher speed)
  - Developing foot stabilization and dynamic: e.g., spiral dynamic screw connection of the foot, load distribution training of the foot in dynamic situations, e.g., side step
  - Knee-bends: increasing the range of motion up to full range of motion, both legs/then also on one leg while checking in a mirror
  - Developing walking alphabet:
    - Step combinations from standing
    - Ankle workout while standing: e.g., rolling from toes to heel
    - Running on forefoot with small amplitude, slowly forwards.
- Training eccentric muscle activity: e.g., low level step-downs.
- Feedback training, also with medium loads: e.g., single-leg squats on proprio-swing system.

Strength training

- Strength endurance training, at the end of the phase, transition to hypertrophy for general musculature, medium range of motion: 4 × 30 reps, for sets; 6 × 15 reps 18/15/12/12/15/18 as pyramid (within completely pain-free range).
- Squats, abductor training, training the core and gluteal muscles, adductor training from abducted position, rotation within permitted range of motion.

Endurance training

- Ergometer training 20–30 mins with increasing duration and wattage depending on physical condition.
- Treadmill exercise: 10-20 mins uphill walking (3-5 km/h) with 10% incline.

Therapeutic climbing

- Initial stabilization from deep joint position in vertical wall area with traction support.
- Approval of rotational starting pattern.
- Step alternating training in the positive wall area, changing moves (up/down, side to side).

9.4 Phase IV

The objective of training in phase IV lies in the patient's ability to resume sporting activities. The sports-therapeutic content of rehabilitation phase IV following muscle and tendon repair operations is summarized for the entire lower extremity in ▶ Section 15.4.

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Knee: Surgical procedure/aftercare

Andreas Imhoff, Knut Beitzel, Knut Stamer, Elke Klein

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DOI 10.1007/978-3-662-49149-2_10,

10.1 Meniscus surgery

10.1.1 Partial meniscus resection

Indication

- Traumatic or degenerative meniscus lesion in the white-white meniscus zone (avascular area of the meniscus).
- Complex, non-reconstructable meniscus lesion.

Surgical method

- Arthroscopic access via an anterolateral and anteromedial portal with diagnostic inspection and assessment of the underlying pathology.

Aftercare

Table 10.1 provides an overview of aftercare.

10.1.2 Meniscus refixation

Indication

- Vertical split in the "red-red" and "red-white" zone (vascularized zones of the meniscus)
- Dislocated bucket handle tear near the base
- Radial split in the "red-red" and "red-white" zone.

Surgical method

- Arthroscopic access via an anterolateral and anteromedial portal with diagnostic inspection and assessment of the underlying pathology.
- Debridement of the edges of the tear and perimeniscal synovia as well as reduction of the meniscus where appropriate.
- Insertion of multiple inside-out sutures and guiding the needles through a posterolateral (lateral meniscus) or posteromedial access (medial meniscus) (Fig. 10.1).
- Extra-articular tying of the sutures on the capsule under arthroscopic repositioning control.
- Alternatively: intra-articular meniscus refixation with fixation systems.

Aftercare

An overview of aftercare can be found in Table 10.2 and Table 10.3.

10

Table 10.1 artial meniscus resection. So specific orthotics necessary

Phase	Range of motion and permitted load	
I	from 1st day post-op:	Free mobility
II	1st to 2nd week post-op:	Pain-adapted partial load with 20kg (depending on pain and effusion)
III	approx. three weeks post-op:	Start of running training (even ground), cycling (click-in pedals three months post-op), swimming (crawl)
IV	approx. 1 month post-op:	Resumption of sport and sport-specific training including contact and high-risk sports (e.g., soccer following consultation with a doctor)

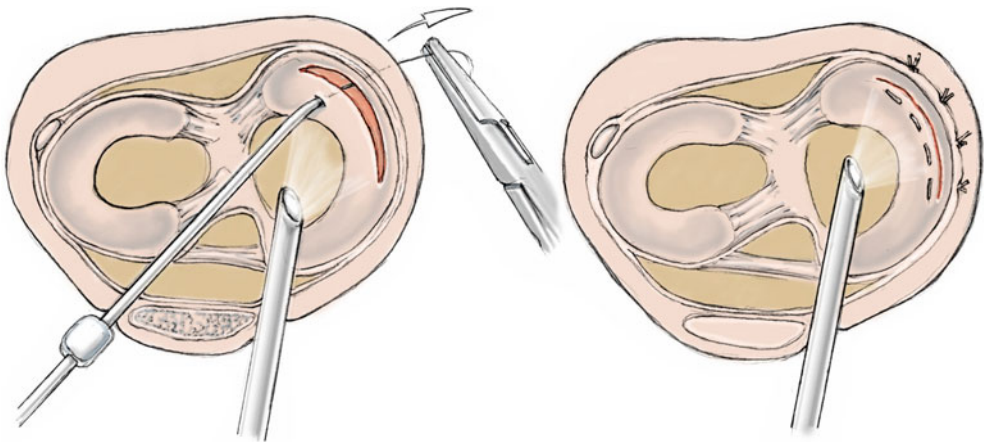

Fig. 10.1 Arthroscopic inside-out suture of the medial meniscus

Table 10.2 Medial meniscus suture/collagen meniscus implant. Four-point hard frame orthotic (medi®-M4-X-Lock-cast) for six weeks post-op

Phase	Range of motion and permitted load	
I	1st to 2nd week post-op:	Partial load 20kg (only when cast extended!, no load during flexion!) Active flexion/extension: 90°/0°/0° (out of the cast)
II	3rd to 6th week post-op:	Full load (ONLY with extension splint, NO load under flexion!) Active flexion/extension: 90°/0°/0° (out of the cast, only permitted in consultation with a doctor)
III	approx. 7 weeks post-op:	Active flexion/extension: free
	approx. 8 weeks post-op:	Start of running training (even ground), cycling (click-in pedals three months post-op), swimming (crawl)
IV	approx. 3 months post-op:	Jogging, resumption of sport and sport-specific training (following consultation with a doctor)
	approx. 6 months post-op:	Contact and high-risk sports (only after careful rehabilitation training)

Table 10.3 Lateral meniscus suture/collagen meniscus implant. Four-point hard frame orthotic (medi®-M4-cast) for six weeks post-op (flexion/extension: 60°/0°/0°)

Phase	Range of motion and permitted load	
I	1st to 6th week post-op:	No weight bearing Active flexion/extension: 60°/0°/0°
II	7th week post-op:	Increase weight bearing based on discomfort Free active flexion/extension (Cave: no load above 90° flexion [squatting, leg presses] for the first three months post-op)
III	approx. 9th week post-op:	Start of running training (even ground), cycling (click-in pedals three months post-op), swimming (crawl)
IV	approx. 3 months post-op:	Jogging, resumption of sport and sport-specific training (following consultation with a doctor)
	approx. 6 months post-op:	Contact and high-risk sports (only after careful rehabilitation training)

10.1.3 Meniscus transplant

Indication

- Unpreservable meniscus or previous total meniscus resection in the event of meniscus border and stable joint.

Surgical method

- Arthroscopic access via an anterolateral and anteromedial portal with diagnostic inspection and assessment of the underlying pathology.
- Measuring and placement of the transplant (e.g. IMC, collagen meniscus implant) and fixation using a meniscus suture (▶ Section 10.1.2).
- Wound closure layer by layer.

Aftercare

The aftercare is the same as that for meniscus refixations (see Table 10.2 and Table 10.3).

10.2 Capsule/ligament reconstructions

10.2.1 Reconstruction of the anterior cruciate ligament (ACL) (double bundle technique with tendons of the gracilis and semitendinosus muscles)

Indication

- Isolated or combined instability in the event of the rupture of the anterior ligament
  - Pre-op: sporting aspirations and subjective instability

- Against surgery: advanced cartilage damage in the event of chronic instability, general hyperlaxicity, arthrosis.

Time

- Acute phase up to 36 hours following trauma or post-primary following drop in the stimulus level, flexion >90° and full extension capability (generally four to six weeks following trauma). Until then, measures to reduce swelling and wearing of a knee orthotic (four-point hard frame orthotic with free mobility) until an irritation-free condition has been reached. Late provision of care (> six weeks post-trauma) in the case of additional concomitant injuries (e.g., in the case of medial collateral ligament injuries; in this case, setting the orthosis to flexion/extension: 20°/20°/0° for two weeks).

Surgical method

- Skin incision approx. 2cm distally to the tibial tuberosity ascending horizontally to the pes anserinus.
- Sample taken from the tendons of the semitendinosus muscle with the tendon stripper and subsequent preparation of the tendons.
- Arthroscopic diagnostics and treatment of concomitant injuries (meniscus surgery, cartilage surgery).
- Preparation of the anatomic femoral and tibial insertion site of the ACL. Decision for a single bundle or double bundle depending on the size of the anatomic insertion sites.
- Insertion of both tibial drill channels (one for the anteromedial and the posterolateral bundle).
- Insertion of both of the femoral drill channels:
  - Anteromedial drill channel at an eleven o'clock position (right knee joint)
  - Posterolateral drill channel at 9:30 position (right knee joint).

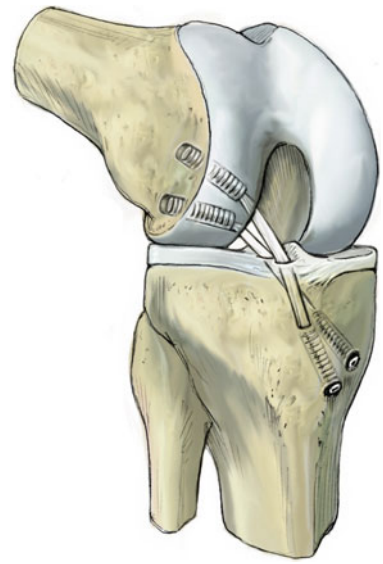

Fig. 10.2 Reconstruction of the anterior cruciate ligament via a double bundle technique and fixation of the bioresorbable interference screws

- Insertion of the two double tendon transplants and fixation with bioresorbable screws (femoral - intra-articular and tibial -extra-articular) while controlling the tension of the transplant (Fig. 10.2).

The precise positioning of the drill channels is the decisive factor in an ensuring an optimum surgical result!

Aftercare

Table 10.4 provides an overview of aftercare.

Table 10.4 ACL replacement surgery. Four-point hard frame orthotic (medi®-M4-cast) for six months (without restriction of movement)

Phase	Range of motion and permitted load	
I	from 1st day post-op:	Free mobility in the knee joint
	for approx. 2 weeks post-op:	Pain-adapted partial load with 20kg (depending on pain and effusion)
II	approx. 8 weeks post-op:	Start of running training (even ground), cycling (click-in pedals three months post-op), swimming (crawl)
III	approx. 3 months post-op:	Jogging
IV	approx. 6 months post-op:	Resumption of sport and sport-specific training (following consultation with a doctor)
	approx. 9–12 months post-op:	Contact and high-risk sports (e.g. soccer/alpine skiing)

10.2.2 Reconstruction of the posterior cruciate ligament (PCL) (double bundle technique with tendons of the gracilis and semitendinosus muscles)

Indication

- Isolated PCL ruptures (posterior compartment >10mm).
- Chronic instability (following fruitless conservative therapy).
- Complex instability (e.g., knee luxation with concomitant posterolateral and anteromedial instability).

Surgical method

- Skin incision approx. 2cm distally to the tibial tuberosity ascending horizontally to the pes anserinus.
- Sample taken from the tendons of the semitendinosus muscle with the tendon stripper and subsequent preparation of the tendons.
- Arthroscopic diagnostics and treatment of concomitant injuries (meniscus surgery, cartilage surgery).
- Preparation of the medial notch as well as the tibial dorsal insertion site via an additional posteromedial portal.
- Insertion of both of the femoral drill channels for the anterolateral and posteromedial bundles:
  - Posterolateral drill channel at one o'clock position (right knee joint)
  - Posteromedial drill channel at four o'clock position (right knee joint).
- Insertion of the joint transtibial drill channel under arthroscopic view (arthroscope in posteromedial portal).

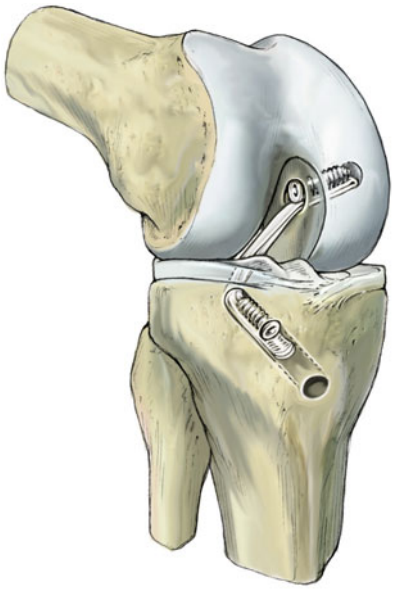

Fig. 10.3 Reconstruction of the posterior cruciate ligament (single bundle technique) and fixation of the bioresorbable interference screws

- Insertion of the two double tendon transplants and fixation with bioresorbable screws (femoral - intra-rticular and tibial -extra-articular) while controlling the tension of the transplant (Fig. 10.3).

Aftercare

Table 10.5 provides an overview of aftercare.

Table 10.5 PCL replacement

Phase	Range of motion and permitted load	
I	1st to 6th week post-op:	Partial load with 20kg medi®-PTS cast ("posterior tibial support"/stretched knee immobilization cast with padding for the calf) for 24 hours per day Passive mobilization in prone position (taken out of the cast by physiotherapist) up to flexion/extension: 90°/0°/0° NO active flexion!
II	7th to 12th week post-op:	Four-point hard frame orthosis (e.g. medi® -M4-PCL cast) during the day and medi®-PTS cast at night
	from 7th week:	Free mobility, beginning with active flexion without weight (following consultation with physician)
III	12th to 24th week post-op:	Four-point hard frame orthosis (e.g., medi® -M4-PCL cast)
	approx. 3 months post-op:	Flexion against weight, start of running training (even ground), cycling, swimming (crawl)
IV	approx. 6 months post-op:	Jogging and sport-specific training (following consultation with a doctor)
	approx. 9–12 months post-op:	Contact and high-risk sports (e.g., soccer if the patient can sufficiently stabilize him/herself)

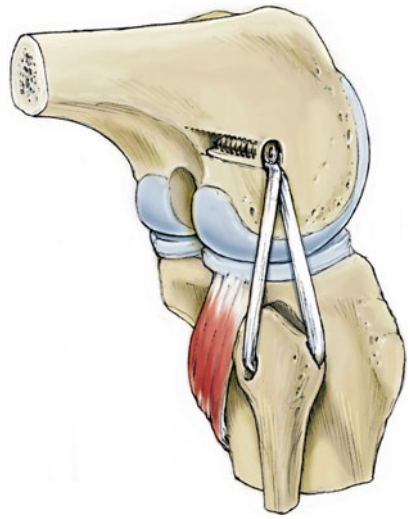

Fig. 10.4 Modified Larson reconstruction

10.2.3 Modified Larson reconstruction (reconstruction of the collateral lateral ligament)

Indication

- Isolated, not primarily adaptable lesion of the LCL level III (>10mm lateral lift-off).
- Chronic postero-lateral instability (**Cave:** Concomitant PCL instability).

Surgical method

- Skin incision approx. 2cm distally to the tibial tuberosity ascending horizontally to the pes anserinus.
- Sample taken from the tendon of the semitendinosus muscle with the tendon stripper and subsequent preparation of the tendon.
- Lateral skin incision at the level of the fibular head and the lateral femoral condyle.
- Preparation and insertion of an anteroposterior drill channel through the fibial head.
- Pulling the tendon transplant through the drill channel and fixing both ends of the transplant with bioresorbable screws on the isometric femoral point of the lateral epicondyle (swing ship-shaped) (Fig. 10.4).

In the case of accompanying posterior cruciate ligament reconstructions, aftercare focuses on the posterior cruciate ligament reconstruction.

Aftercare

Table 10.6 provides an overview of aftercare.

10.3 Osteotomies

10.3.1 High tibial osteotomy (HTO): valgus osteotomy with medial opening (open wedge)

Indication

- Unicompartmental medial gonarthrosis.
- Axial correction in the event of tibial vagus misalignment in combination with reconstructive interventions in the medial compartment or in the case of knee joint instabilities as well as capsular/ligament reconstructions.

Surgical method

- Diagnostic arthroscopy (potential treatment of additional pathologies). In the contract medial compartment, potentially also arthroscopic release of the MCL.
- Approx. 6cm longitudinal skin incision above the tibial tuberosity.
- Preparation of the tibial medial collateral ligament approach on the pes anserinus with detachment of the periosteum (potentially medial collateral ligament release).
- Marking the osteotomy line with two transfixion wires.
- Osteotomy ascending horizontally with oscillating saw along the transfixion wire and ventrally ascending osteotomy dorsally to the tibial tuberosity.

Table 10.6 Modified Larson reconstruction. Four-point hard frame orthotic (medi®-M4-OA-cast) for six months

Phase	Range of motion and permitted load	
I	from 1st day post-op:	Mobility in the knee joint: flexion/extension: free/0°/0° no overstretching!
II	for 6 weeks post-op:	Partial load with 20kg
III	approx. 12 weeks post-op:	Start of running training (even ground), cycling, swimming (crawl)
IV	approx. 6 months post-op:	Resumption of sport and sport-specific training (following consultation with a doctor)
	approx. 9–12 months post-op:	Contact and high-risk sports

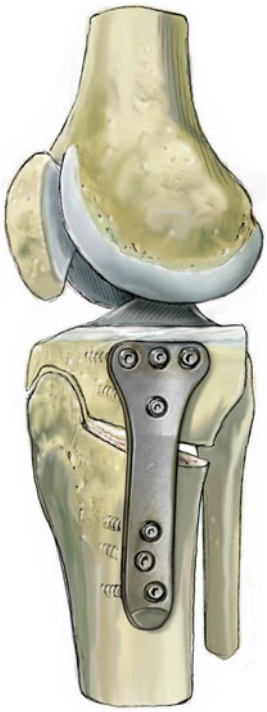

Fig. 10.5 High tibial osteotomy (open wedge) and osteosyntheses with fixed angle plate

- Carefully spreading the osteotomy line until the desired corrective angle has been reached (observing tibial slope).
- Fixation of the osteotomy through stable angle plate holder (Fig. 10.5).
- Wound closure layer by layer.

Aftercare

Table 10.7 provides an overview of aftercare.

10.3.2 Lateral closing valgus osteotomy (closed wedge/stable-angle implant)

Indication

- Unicompartmental medial gonarthrosis (primarily when beginning retropatellar arthrosis or corrective angle >15°).
- Axial correction in the event of tibial vagus misalignment in combination with reconstructive interventions in the medial compartment or in the case of knee joint instabilities as well as capsular/ligament reconstructions.

Surgical method

- Potentially Arthroscopy.
- Approx. 5-8cm skin incision laterally to the tibial tuberosity.
- Detachment of the tibialis anterior muscle.
- Marking the osteotomy wedge with transfixion wires and measurement block.
- Removing the osteotomy wedge and fixation of the osteotomy with stable-angle implant.
- Wound closure layer by layer.

Aftercare

Table 10.8 provides an overview of aftercare.

10.3.3 Supracondylar osteotomy: lateral lift-off of valgus osteotomy

Indication

- Unicompartmental gonarthrosis under femoral valgus misalignment.
- Rotational misalignment of the distal femur.

Surgical method

- Arthroscopy with treatment for potential concomitant pathologies.

Table 10.7 High tibial osteotomy (HTO). Four-point hard frame orthotic (medi®-M4-OA-cast) for six weeks post-op (only with additional medial collateral ligament release)

Phase	Range of motion and permitted load	
I	from 1st day post-op:	Free mobility
	1st to 2nd weeks post-op:	Partial load with 20kg, no heavy load or resistance distally to the osteotomy
II	from 3rd week post-op:	Increase weight load by 20kg/week under radiological and clinical supervision
III	approx. 3 months post-op:	Start of running training (even ground), cycling, swimming (crawl)
IV	approx. 6 months post-op:	Resumption of sport and sport-specific training (e.g. alpine skiing following consultation with a doctor)
	approx. 9–12 months post-op:	Contact and high-risk sports (following consultation with a doctor)

Table 10.8 Valgus osteotomy (closed wedge). Four-point hard frame orthotic (medi®-M4-OA-cast) for six weeks post-op (only with additional medial collateral ligament release)

Phase	Range of motion and permitted load	
I	from 1st day post-op:	Free mobility
II	1st to 2nd weeks post-op:	Partial load with 20kg No shear load or distal resistance
	from 3rd week post-op:	Increase weight load by 20kg/week under radiological and clinical supervision
III	approx. 3 months post-op:	Start of running training (even ground), cycling, swimming (crawl)
IV	approx. 6 months post-op:	Resumption of sport and sport-specific training (e.g., alpine skiing following consultation with a doctor)
	approx. 9–12 months post-op:	Contact and high-risk sports (following consultation with a doctor)

- Approx. 8-10cm ascending lateral skin incision proximally to the lateral epicondyle of femur.
- Longitudinal splitting of the iliotibial tract and mobilization of the vastus lateralis muscle.
- Detachment of the periosteum, insertion of two Schanz screws to control rotation.
- Use of transfixion wire to mark the osteotomy line.
- Diagonally descending osteotomy with oscillating saw.

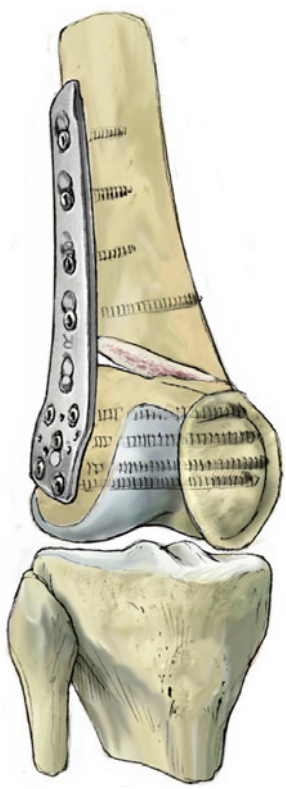

Fig. 10.6 Supracondylar osteotomy (open wedge) and fixation with fixed angle plate

- Carefully spreading the osteotomy line until the desired corrective angle has been reached and fixation with angle-stable plate (Fig. 10.6).
- Wound closure layer by layer.

Aftercare

Table 10.9 provides an overview of aftercare.

10.4 Endoprosthesis

10.4.1 Knee joint prosthesis

Indication

- **Total endoprosthesis (TEP):**
  - "Pangon" arthrosismulticompartmental arthrosis
  - Osteonecrosis (Ahlbäck's disease).
- **Unicondylar sliding prosthesis:**
  - Arthrosis of a compartment.
- **Patellofemoral joint replacement:**
  - Arthrosis of the femuropatellar bearing.

Surgical method

- Central skin incision with medial arthrotomy (in the event of a contracted valgus arthrosis, potentially lateral capsulotomy).
- Avoiding the patella (not necessary in the case of unicondylar prosthesis).
- Partial synovectomy, osteophyte removal.
- Bone resection through sawing template, adjusting the prosthesis and soft tissue balancing.
- Fixation with cement or using press fit techniques while controlling stability and soft tissue balancing.
- Denervation of the patella and potential removal of parapatellar osteophytes (replacement of rear patella surface in the case of retropatellar arthrosis).
- Wound closure layer by layer (Fig. 10.7).

Table 10.9 Supracondylar osteotomy/lateral opening vagus osteotomy. No specific orthotic treatment necessary

Phase	Range of motion and permitted load	
I	from 1st day post-op:	Free mobility
II	1st to 6th weeks post-op:	Partial load with 20kg No shear load or distal resistance
III	from 7th week post-op:	Increase weight load by 20kg/week under radiological and clinical supervision
IV	approx. 3 months post-op:	Start of running training (even ground), cycling, swimming (crawl)
	approx. 6 months post-op:	Resumption of sport and sport-specific training (following consultation with a doctor)
	approx. 9–12 months post-op:	Contact and high-risk sports (following consultation with a doctor)

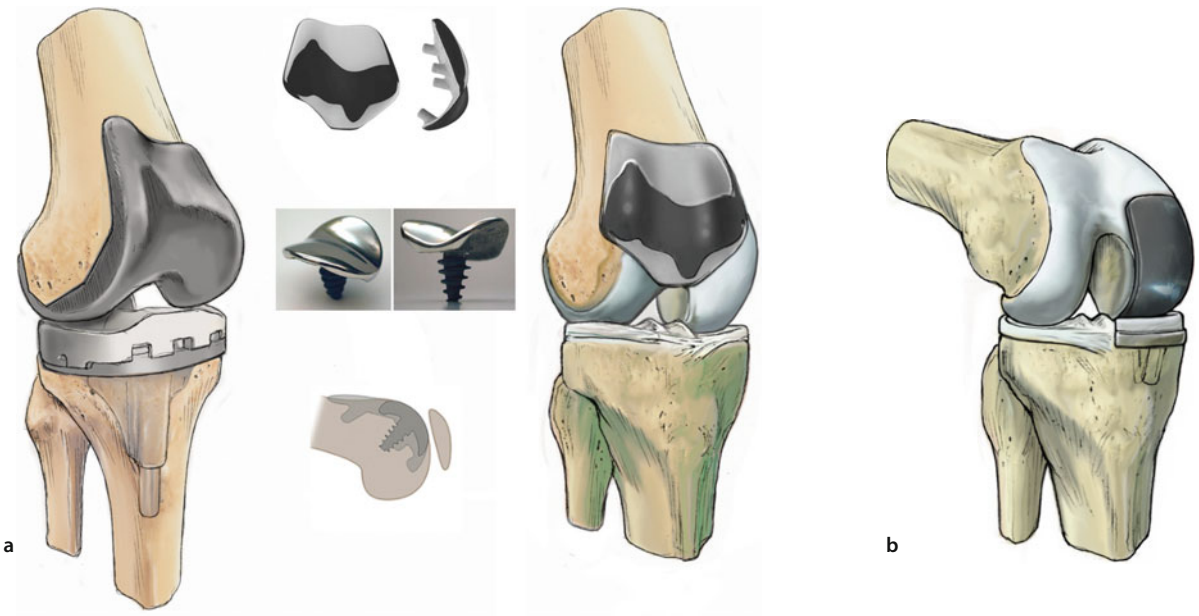

Fig. 10.7a,b Knee joint prostheses. **a** Total knee arthroplasty of the knee joint and unicompartmental replacement of the femuropatellar joint (inlay: HemiCAP® Wave, Arthrosurface, Franklin, MA, USA, onlay: Journey™ PFJ, Smith & Nephew, Andover, MA, USA), **b** Unicompartmental replacement with unicondylar sliding prosthesis

Aftercare

Table 10.10 provides an overview of aftercare.

Table 10.10 Endoprosthesis of the knee joint. No specific orthosis therapy required

Phase	Range of motion and permitted load	
I	from 1st day post-op:	Free mobility
	1st to 2nd weeks post-op:	Partial load with 20kg (depending on pain and effusion)
II	from 3rd week post-op:	Pain-adjusted increase weight load by 20kg/week
III	from 7th week post-op:	Swimming (crawl)
IV	approx. 3 months post-op:	Cycling
	approx. 6 months post-op:	Resumption of sport and sport-specific training (following consultation with a doctor – according to recommendations for sport following endoprosthetics)

10.5 Patella surgery

10.5.1 Trochleaplasty

Indication

- Recurring dislocation of the patella due to dysplasia of the femuropatella bearing.

Surgical method

- Central skin incision with lateral arthrotomy with medial eversion of the patella.
- Osseous removal of the trochlea from proximal to distal with a cutting tool approx. 2mm deep.
- Modulation of a new trochlea groove with the fraise.
- Adjusting the cartilage to the new trochlea groove and fixation with two transosseous vicryl sutures.
- Suturing the synovia and the detached cartilage layer using resorbable suture material.
- Leaving the lateral release and potentially medial tightening or additional reconstruction of the medial patellofemoral ligament (MPFL) (Fig. 10.8).
- Wound closure layer by layer.

Aftercare

Table 10.11 provides an overview of aftercare.

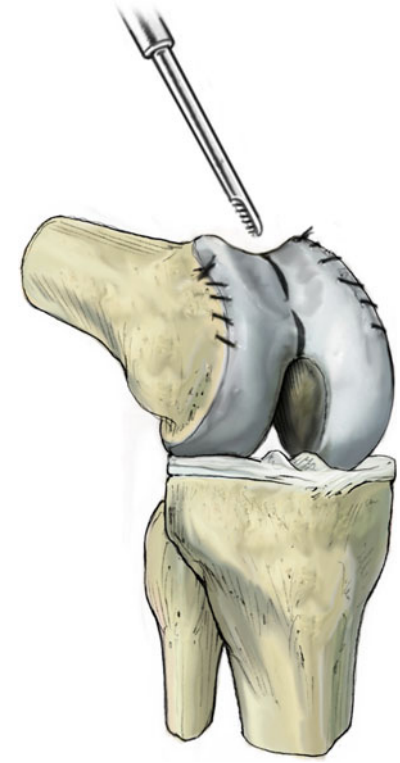

Fig. 10.8 Trochleoplasty

10.5.2 Reconstruction of the medial patellofemoral ligament (MPFL)

Indication

- Recurring dislocation and instability of the patella in the area of flexion: 0–40°.
- Traumatic luxation of the patella resulting in instability.

Surgical method

- Diagnostic arthroscopy to assess the existing pathology.
- Approx. 2cm long incision distally to the tibial tuberosity with subsequent preparation and sample taken from the tendon of the gracilis muscle with the tendon stripper.

Table 10.11 Trochleoplasty. Four-point hard frame orthotic (medi®-M4-cast) for six weeks 24 hours/day

	Range of movement and restrictions of the cast	
	1st to 2nd week post-op:	Active flexion/extension: 60 °/20 °/0 °
	3rd to 6th week post-op:	Active flexion/extension: 90°/10°/0°
	from 7th week post-op:	Range of movement free and, at the same time, beginning active quadriceps exercising
Phase	**Permitted loads**	
I	1st to 2nd week post-op:	Relaxation, only isometric quadriceps activity
II	3rd to 6th week post-op:	No weight bearing (10kg partial load while standing)
	from 7th week post-op:	Increase weight load by 20kg/week
III	approx. 4 months post-op:	Start of running training (even ground), cycling, swimming (crawl)
IV	approx. 6 months post-op:	Resumption of sport and sport-specific training (following consultation with a doctor)
	approx. 9–12 months post-op:	Contact and high-risk sports

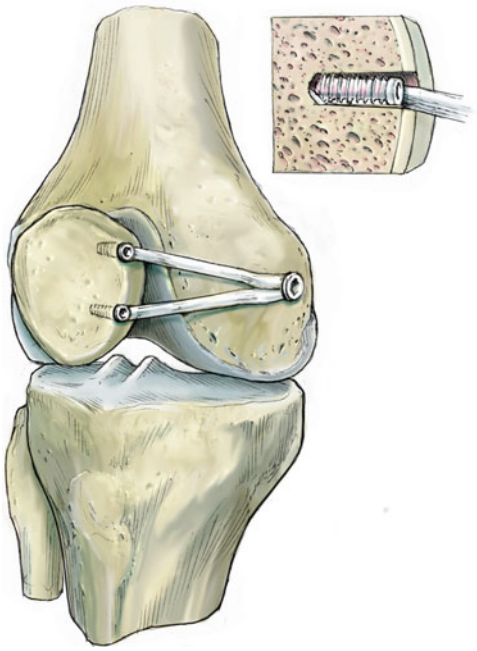

Fig. 10.9 Anatomical reconstruction of the medial patellofemoral ligament in aperture technique with autologous gracilis transplant

- Approx. 2cm skin incision in the area of the insertion of the MPFL on the medial edge of the patella.
- Placing both patellar fixation points and over drill.
- Fixation of both transplant ends, each with a SwiveLok® anchor (Arthrex).
- Preparation and passage of the double tendon transplant into the anatomical capsule layer.
- Subcutaneous preparation of the femoral insertion and placement of a further 2cm long skin incision above the insertion site.
- Placing the wire in the anatomic insertion site and further drilling.
- Retracting the transplant and femoral fixation under tension control with a bioresorbable screw (Fig. 10.9).
- Wound closure layer by layer.

Aftercare

Table 10.12 provides an overview of aftercare.

10.5.3 Tuberosity transposition

Indication

- Recurring patella luxations with an increased Q angle and TTTG index (tuberositas-tibia-trochlea-groove) with lateral compression.

Surgical method

- Anterolateral skin incision (approx. 7cm at the height of the tibial tuberosity).
- Preparation of the tibial tuberosity and wedge-shaped osteotomy with an oscillating saw over 4–6cm.
- Medialization and potential proximalization of the splint and fixation with two osteosynthesis screws following control of the patellofemoral sliding.
- Wound closure layer by layer.

Aftercare

Table 10.13 provides an overview of aftercare.

10.6 Arthrolysis

10.6.1 Arthrolysis of the knee joint

Indication

- Limitations of movement > 5° extension and < 90° flexion (should conservative treatment fail).

Table 10.12 Reconstruction of the medial patellofemoral ligament (without dysplasia). Four-point hard frame orthotic (medi®-M4-cast) for six weeks post-op

	Range of movement and restrictions of the cast	
	1st to 6th week post-op:	Active flexion/extension: 90°/0°/0°
Phase	**Permitted load**	
I	1st to 2nd week post-op:	20kg partial load with subsequent increase depending on pain and effusion
II	approx. 6 weeks post-op:	Start of running training (even ground), cycling, swimming (crawl)
III	approx. 3 months post-op:	Resumption of sport and sport-specific training (following consultation with a doctor)
IV	approx. 6 months post-op:	Contact and high-risk sports

Table 10.13 Tuberosity displacement. Hard frame orthotic (e.g. medi®-M4-cast) for six weeks post-op

	Range of movement and restrictions of the orthesis	
	1st to 2nd week post-op:	Active flexion/extension: 30°/0°/0°
	3rd to 4th weeks post-op:	Active flexion/extension: 60°/0°/0°
	5th to 6th weeks post-op:	Active flexion/extension: 90°/0°/0°
	from 7th week post-op:	Under radiological and clinical supervision: free active flexion and extension
Phase	**Permitted loads**	
I	1st to 6th week post-op:	No weight bearing (then gradually increasing weight load by 20kg/week under medical supervision) No active quadriceps exercises, only quadriceps isometry exercises with resting leg permitted in extension position
II	from 7th week post-op:	Increase weight load by 20kg/week under radiological and clinical supervision
III	approx. 4 months post-op:	Start of running training (even ground), cycling, swimming (crawl)
IV	approx. 6 months post-op:	Resumption of sport and sport-specific training (following consultation with a doctor)
	approx. 9–12 months post-op:	Contact and high-risk sports

Table 10.14 Arthrolysis of the knee joint. No specific orthosis therapy required

Phase	Range of motion and permitted load	
I II	1st to 2nd week post-op:	Partial load with 20kg Intensive exercise via CPM
III IV	from 3rd week post-op:	Increasing load up to full load (depending on pain and effusion), released as able to resume sporting activities

Surgical method

- Insertion of both arthroscopic standard accesses (auxiliary accesses where required).
- Loosening of clamps, removal of free joint bodies, capsular release and removal of osteophyte cultivations depending on the pathology.
- Wound closure layer by layer.

Aftercare

Table 10.14 provides an overview of aftercare.

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Knee: Rehabilitation

Andreas Imhoff, Knut Beitzel, Knut Stamer, Elke Klein

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11.1 Phase I

Phase I of rehabilitation following surgery corresponds to phase I following hip surgery (▶ Section 7.1).

11.2 Phase II

Goals (in accordance with ICF)

Goals of phase II (in accordance with ICF)

- **Physiological function/bodily structure:**
  - **Promoting resorption**
  - **Regulation of impaired vegetative and neuromuscular functions**
  - **Improving joint mobility**
  - **Avoiding functional and structural damage**
  - Improving joint stability
  - Improvement in functions affecting sensorimotor function
  - Retaining the physiological movement pattern while walking
  - Pain relief
- **Activities/participation:**
  - Developing dynamic stability when walking, while observing load guidelines
  - Optimization of the support function, core and pelvic stability in movement
  - Independence when meeting the challenges of daily routines
  - Exploiting the limits of movement and load
  - Learning a home training program

11.2.1 Physiotherapy

Patient education

- Discussing the content and goals of treatment with the patient.
- To facilitate trust in the patient's movement by explaining the current status of wound healing and the current associated resilience of the tissue in language they can understand.
- Providing the patient with further information regarding the limitations associated with the operation:
  - **Meniscus surgery:**
    - Medial meniscus suture/CMI: load only in extension, no load under flexion
    - Lateral meniscus suture/CMI: pressure relief
    - Partial meniscus resections: avoiding squatting too deeply
  - **Capsule/ligament reconstructions:**
    - No rotation or shearing forces (no turning with stationary leg)
    - Movement transitions under co-contraction to stabilize the muscles of the knee joint
    - Posterior cruciate ligament reconstructions: No active knee flexion by tensing the ischiocrural muscles
    - ACL: No active knee extension in open system via quadriceps femoris muscle
    - Larson plastic surgery: no overstretching of knee joint
  - **Endoprosthetics:**
    - No rotation forces under load, e.g., turning/change of direction with static foot
    - No kneeling
    - When sitting down and standing up, move the leg that underwent surgery forward in order to avoid uncontrolled load and forced movements
  - **Patella treatment:**
    - Trochleoplasty: no extension allowed, relaxation for six weeks
    - Tuberosity displacement: no raising the extended leg; risk of tear by pulling the quadriceps femoris muscle. Better: Isometry of the quadriceps muscle only with supported leg, relaxation for six weeks
  - **Arthrolysis:**
    - Explaining the necessity for intensive mobilization techniques to promote the own initiative and responsibility of the patient. The active cooperation of the patient is of particular importance here: consistent stretching, holding and mobilization are pre-requisites if the best possible surgical outcome is to be achieved. A great deal of motivation and commitment is therefore required
    - Administration of analgesics to complement treatment
    - Position: The leg should be supported above heart height on cushions or covers to assist in venous back flow
    - The leg is held in maximum flexion and extension positions alternatively in a Quengel cast. Changing position after two hours, provided that the patient can tolerate this. Otherwise, the change in position takes place at more frequent intervals.
- Handling the orthotic, if necessary.
- Controlling crutches: length, handling.
- Learning movement transitions through joint-stabilizing muscle tension (co-contraction).

Fig. 11.1 Lymph taping

- Learning movement transitions through "leg crane" to reduce the weight of the legs by raising against the weight: use the leg that did not undergo surgery distally on the lower leg of the side that underwent surgery to support the leg.

Prophylaxis

- Everyday activities.
- Activating the muscle pump through the terminal movement of the ankle joints.
- Isometric training of the leg muscles.
- In the event of pain, increased swelling and temperature increases in the corresponding areas: Controlling thrombosis painful tender points.
- Deep breathing measures.

Promoting resorption

- Elevation.
- Active decongestion exercises.
- Active decongestion exercises: dynamic terminal ankle joint movements in all directions of movement with a stretched leg, isometric muscle activity of all leg muscles, e.g., tensing once per second.
- Lymph taping (Fig. 11.1).
- Manual lymph drainage.
- Cryocuff.

Improving mobility

- Soft tissue treatment:
  - Neighboring muscles: ischiocrural muscles, psoas muscle, iliac muscle, quadriceps femoris muscle, adductor group, pelvic trochanter muscles (primarily piriformis muscle), gluteal muscles, quadratus femoris muscle, iliotibial tract (frequently reflectively hypertonic in the case of supracondylar adjustments, as it is split lengthways during surgery and/or the lateral vastus muscle is mobilized), soleus muscle, gastrocnemius muscle, popliteus muscle, long muscles of the foot (**Cave:** Tibialis anterior muscle is detached in the case of high tibial adjustments) through:
    INIT
    Strain-counterstrain
    MET: Five second isometric contraction – relaxation – stretching the muscle. Repeat five times or until no further extension occurs
    Functional massage
    Subsequently, potential stretching of the shortened structures (hold stretch position for at least one minute).
  - Treating ligament structures through cross-fiber massage on: meniscofemoral and meniscotibial ligaments, suprapatellar recess, patellar ligament
  - Fascia treatment through pressure and release techniques on the pelvis and the lower extremity, e.g., long plantar ligament, fascia cruris, (Fig. 11.2), lateral thigh fasciae, ischiatic fascia on the thigh and lower leg, fascia lata, plantar fascia
  - Treatment of the myofascial structures: superficial back and front lines, spiral line and lateral line (Fig. 11.3).
- Active and passive joint mobilization:
  - Actively-assisted movement of the knee joint within the pain-free range, e.g., with the use of skateboards
  - Independent mobilization through wall slides, simultaneous leg axis training

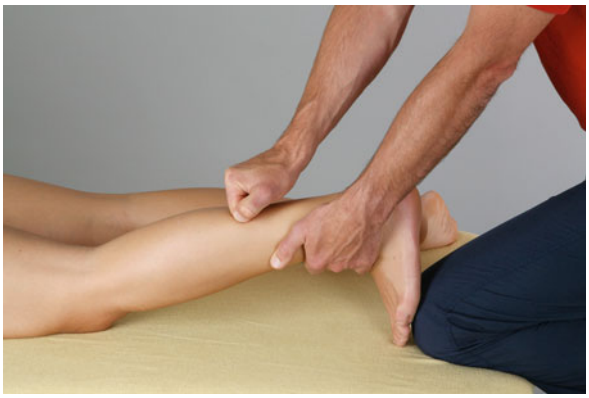

Fig. 11.2 Treating the fascia cruris through pressure and release techniques

Fig. 11.3 Treatment of the myofascial structures: superficial front line/spiral line

Patella positions

- **Glide:** the patella shifting sideways, usually laterally (may also slide medially in the case of flexion)
- **Tilt:** tilting the patella sideways (medial and lateral patellofemoral joint line should be the same size)
- **Rotations:** ER – the lower pole lies laterally to the upper, IR – lower pole lies medially to the upper
- **A/P tilt:** Tilting the patella on sagittal level – the lower pole is tilted in posterior direction in comparison to the upper

- Treatment of **patella problems** (exception: MPFL reconstruction) to improve joint mobility
  - Treatment of patella positions
    Improvement in the timing of the vastus medialis oblique muscle (VMO should be activated earlier and more strongly than the VLO along the entire path of movement in eccentric and also concentric exercise)
    Subsequent integration into the overall muscle synergies (supinators, adductors, gluteal muscles)
    Leg axis training in order to better control the dynamic Q angle (less valgus, less medial rotation of the lower leg)
    Relaxation or stretching to tight support structures (retinacula, iliotibial tract, VLO, patella tendon.

- **Endoprosthetics:**
  Expanding movement, e.g., with the dynamic rotation technique from the PNF concept: concentric contraction between agonist and antagonist alternatively without a rest phase
  Independent mobilization and simultaneous leg axis training through wiping movement exercise while sitting, while exercising with the foot on a towel on slippery surface axially in extension and in flexion (Fig. 11.4)

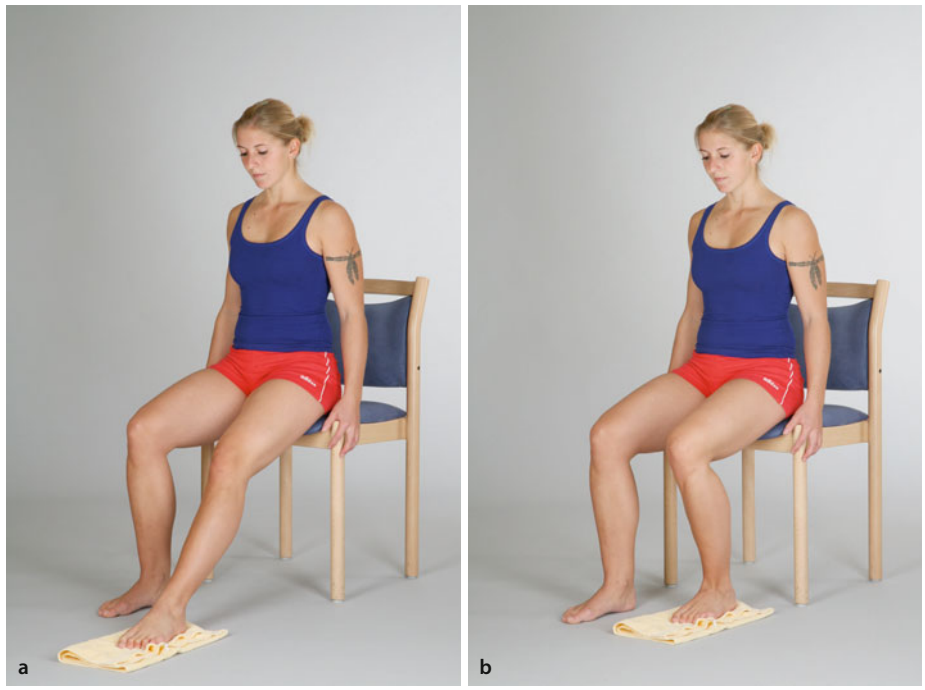

Fig. 11.4a,b Independent mobilization and simultaneous leg axis training through wiping movement exercise while sitting, while exercising with the foot on a towel on slippery surface axially **a** in extension and **b** in flexion

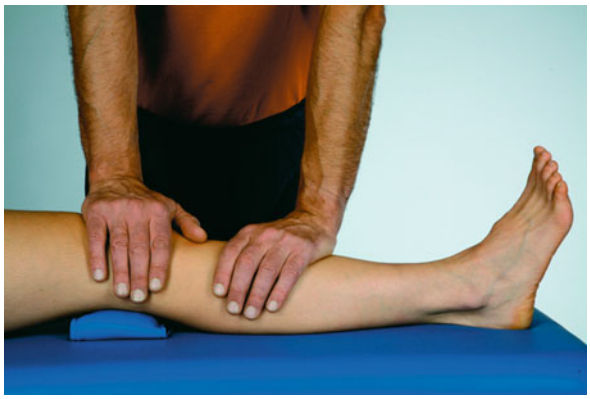

Fig. 11.5 Intermittent compression to the femurotibial joint to stimulate the synovial membrane

Careful traction (level I-II) with/without movement.
Intermittent compression to the femurotibial joint to stimulate the synovial membrane (begin carefully at the end of phase II (Fig. 11.5).

The turn-over of the synovial fluid following an operation or immobilization takes approx. 2-3 weeks. During this time, the distribution of pressure on the joint surfaces is not optimum and the protection of the hyaline cartilage is thereby reduced! Due to the diminished load-bearing capacity, shearing movements should be avoided as far as possible!

- Activation of the quadriceps femoris muscle: promoting sliding between the surface and deep layer of the suprapatellar recess to prevent adhesions.
- Counter-bearing mobilization from the functional kinetics concept (**Cave:** Not in the event of cartilage therapy).
- Mobilization of the neighboring joints: pelvis, lumbar spine, distal and proximal tibiofibular joint depending on findings (**Cave:** In the case of fibula osteotomies) (Fig. 11.6)
- Controlling pelvic position and, depending on results, immediate correction.
- Targeted manual joint mobilization techniques to improve the elasticity of the joint capsule in the case of **arthrolysis**:
  - Mobilization in the femurotibial joint to the limit of movement in all directions: extension – extension/final rotation – flexion – flexion/IR – flexion/ER in accordance with the Kaltenborn/Evjenth principle: traction level 3 and dynamic mobilization. Maitland mobilization levels 3 and 4
  - Frequent stimuli and smooth techniques to give the tissue time to react! Precise setting of the direction of mobilization on three levels
  - It is not possible to avoid pain completely in this case! The patient should be given sufficient painkillers before treatment
  - Mobilization under compression.
- Soft tissue techniques: deep friction in the case of arthrolysis or endoprosthetics.
- Mobilization via hold-relax and contract-relax from sitting and prone position.
- Relaxation of hypertonic muscles through MET (five second isometric contraction – relaxation – stretching the muscle, five reps or until no further extension occurs).

Fig. 11.6a,b Mobilization of the neighboring joints. **a** Distal, **b** Proximal tibiofibular joint

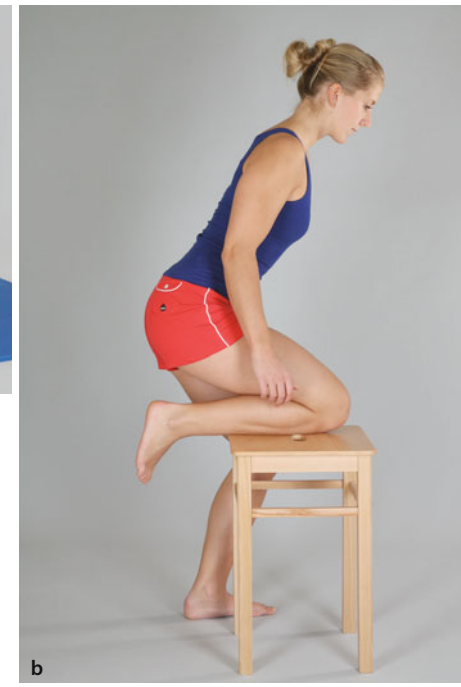

Fig. 11.7a,b Automobilization for extension and flexion

- Dynamic mobilization in conjunction with heat pack on the thigh muscles.
- Longer static stretching in conjunction with the application of heat on the sling table.
- Cryokinetics.
- Mobilization of the neural structures locally and along the track.
- Independent training program:
  - Active movement within full range of motion in different starting positions
  - Stretches
  - Automobilization for extension and flexion (Fig. 11.7).

Regulation of vegetative and neuromuscular functions

- Treatment in the orthosympathetic and parasympathetic areas of origin: Th8–L2 as well as S2–S4: Manual therapy, hot rolls, electrotherapy, oscillations.
- Treatment of possible trigger points: TFL, sartorius muscle, quadriceps femoris muscle, adductors, popliteus muscle.
- Vegetative slump: spine flexion + spine lateral flexion + cervical spine lateral flexion and extension.
- Treatment of neurolymphatic and neurovascular reflex points:
  - Gluteus maximus, medius and minimus muscles
  - Ischiocrural muscles
  - Popliteus muscle
  - Rectus femoris muscle
  - Sartorius muscle
  - Tensor fasciae latae (TFL)
  - Tibialis anterior and posterior muscles.

Practical tip

Neurolymphatic reflex points for which treatment is indicated are to be distinguished from the surrounding tissue through palpation. They are usually painful and feel doughy, edematous and swollen.

- Treatment: a massage of the area without too much pain for at least 30 seconds. For very painful areas, start with gentle pressure and gradually increase pressure. A reduction in sensitivity should result from the treatment.

Neurovascular reflex points are not as noticeable upon sensitive palpation as NLR, but can be detected by the therapist.

- Treatment: Determine NVR with two or three fingertips and gently move in different directions. The direction with the greatest tension, or where pulsation can be detected, is held for 30 seconds.

Improving sensorimotor function

- Electrical muscle stimulation: visible muscle contraction.

Fig. 11.8 Fascia mobilization

- Fascia mobilization (Fig. 11.8).
- PNF above the upper extremity, contralateral side (overflow) and the core in gait pattern, e.g., side that underwent surgery in supporting leg phase resting against the wall in closed system, starting position lateral position/supine position:
  - Contralateral leg in flexion-adduction-ER
  - Ipsilateral arm in ulnar thrust
  - Ipsilateral arm in flexion-abduction-ER
  - In the case of **endoprosthetics:**
    For supporting leg activity on the side that underwent surgery:
    Starting in lateral/supine position: leg pattern flexion adduction ER contralaterally
    Starting in lateral/supine position: foot pattern plantar flexion pronation ipsilaterally
    Starting in lateral position with side that underwent surgery open: pelvic pattern in anterior elevation
    For swing leg activity on the side that underwent surgery:
    Starting in lateral/supine position: Leg pattern extension abduction IR contralaterally
    Starting in supine position/lateral position: Foot pattern in DE inversion for further tension in flexion-adduction-ER or DE eversion for flexion-abduction-IR (symmetrically or reciprocally) ipsilaterally
    Starting in supine/lateral position/seated: Ipsilateral arm pattern in extension-abduction-IR.
- 3D perception of the foot in accordance with Janda or Spiraldynamik ("perpendicular heel" exercise, foot pendulum).
- PNF concept: e.g., via upper extremity, contralateral side and core (overflow) or starting in seated position; apply prescribed rotational resistance on PNF diagonals in closed system to lower leg or thigh to activate the surrounding muscles (Fig. 11.9).
- Angle reproduction: target training, i.e., the patient should aim at a point with open eyes, then head for

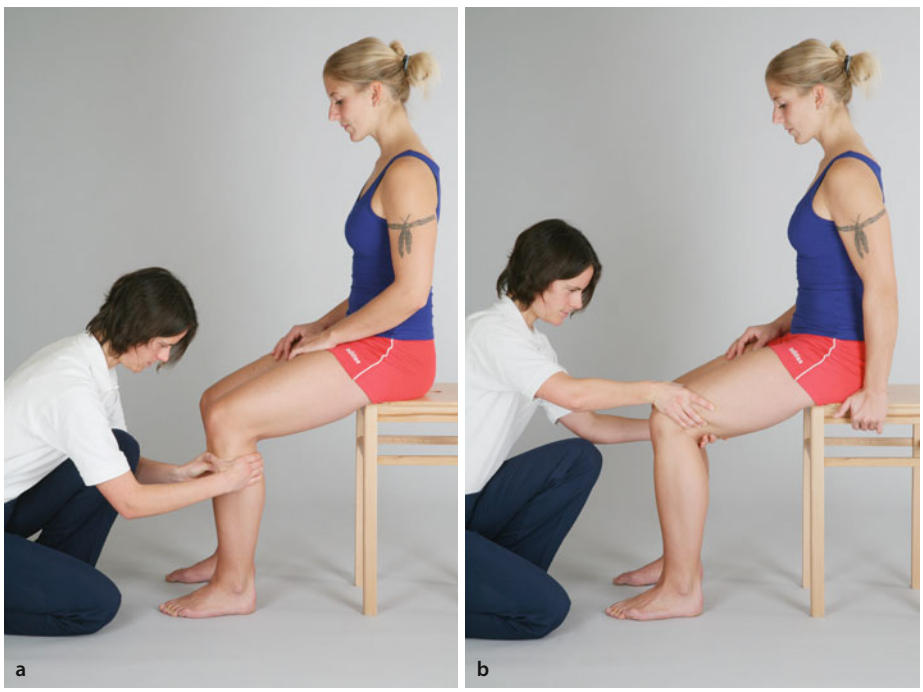

Fig. 11.9a,b PNF concept, starting in seated position: apply prescribed rotational resistance on PNF diagonal patterns in closed system to **a** lower leg or **b** thigh to activate the surrounding muscles

Fig. 11.10 Tai chi for physical perception; partially weight-bearing leg is in front

the point with closed eyes. Also in conjunction with the laser pointer. A deviation of between 2° and 5° is normal.

- Closed system exercises on unstable surfaces: e.g., starting in sitting or half-sitting position in conjunction with upper extremity and/or unstable aids, e.g., balloon, balance board.
- Tai chi for physical perception; partially weight-bearing leg is in front (Fig. 11.10).

Fig. 11.12 Gyrotonic: Swimming breast stroke

- Coordination training under relaxation or partial load (Fig. 11.11).
- Isometry.
- Increasing closed chain sensomotoric exercises.
- Awareness training for the knee joint and the entire leg axis as well as posture (Fig. 11.12).

In the case of patella treatment

- Activation of the quadriceps femoris muscle with tactile and visual aids for the resting leg:
  - Stimulation to the cranial patella
  - Foot pattern in DE + supination
  - Canalization: exploiting overflow in the gait pattern, e.g., via upper extremity/core pattern, lifting and chopping to promote ipsilateral supporting leg phase activity starting in supine, lateral and seated position

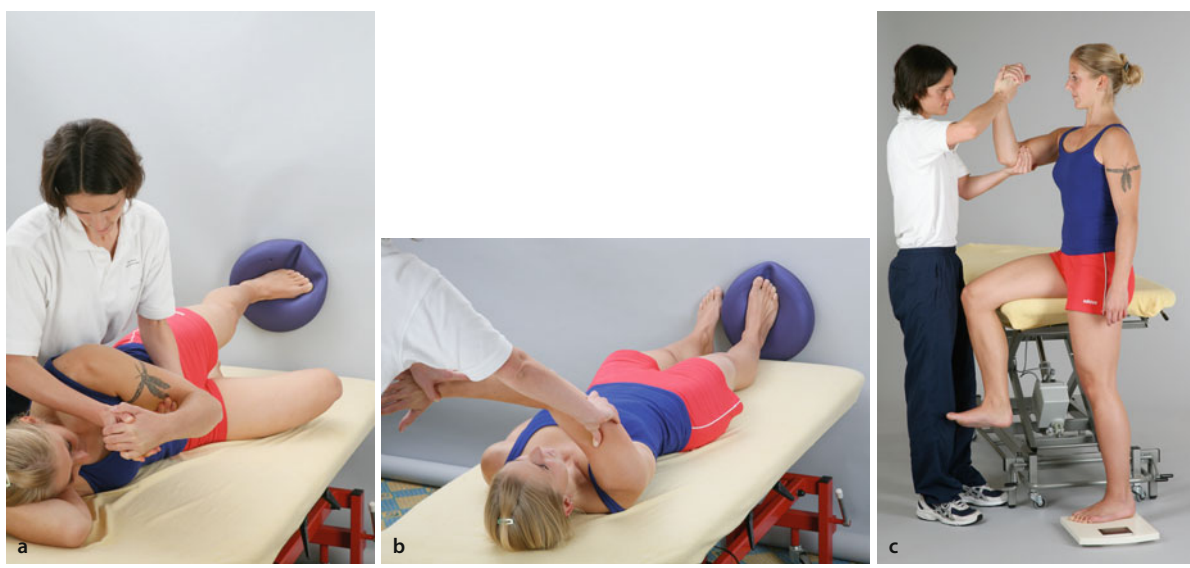

Fig. 11.11a–c Coordination training under relaxation or partial load in gait pattern via arm pattern in various starting positions

Fig. 11.13 Sensorimotor function training: starting in half-seated position while controlling core stability and partial load on scales

- Sensorimotor function training from various starting positions (sitting, half-sitting, standing) while holding the core static in conjunction with the upper extremity or unstable aids, e.g., balloon, balance board (Fig. 11.13).

In the event of arthrolysis

- Tai chi for physical perception.
- Exercising on tilt board on both legs, trampoline, large platform, therapy rocks with
  - Eyes open
  - Looking away
  - Eyes closed.
- Increasing intensity of closed system isokinetics to improve intramuscular coordination (alternatively shuttle).
- Reactive single leg stabilization (e.g., lunge). Rotational control on instable/stable support surface.
- Travelling around a course.
- Acceleration and braking training.
- Changing between concentric and eccentric muscle phase, e.g., the quadriceps muscle: Movement transition from standing towards half knee stand via pelvic pattern through the combination of isotonics technique.
- Gyrotonic.
- Strengthening/improving innervation in the muscular chains by exercising using the Redcord® system.

Stabilization and strengthening

- Isometry from various angle positions.
- "Knee circles" with co-contraction from lateral position (adduction, abduction in hip joint) and prone position (gluteals) (Fig. 11.14).
- Strengthening the supporting muscles of the arms.
- Awareness of three-point foot weight-bearing as a basis for the leg axis, with static core involvement.

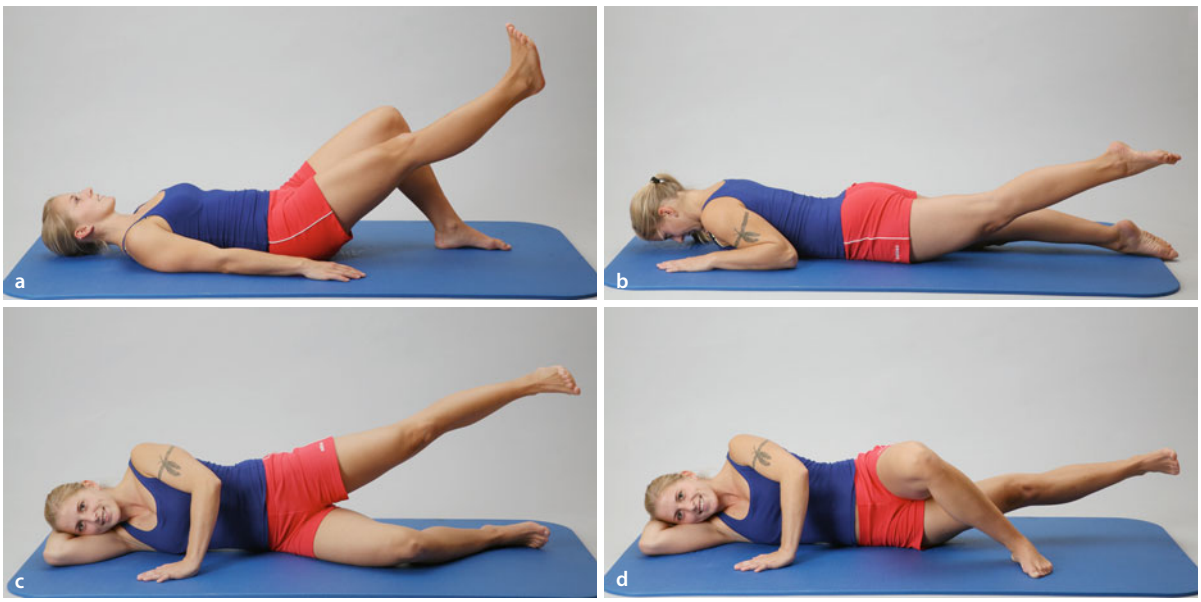

Fig. 11.14a–d "Knee circles" with co-contraction **a** In lateral position, **b** From prone position (gluteals) **c,d** From lateral position (adduction, abduction in hip joint)

The pressure-bearing points of the foot are supported on wooden blocks. The patient should firstly perceive the pressure points and then build up the arch of the foot.

- Leg axis training: Using a mirror, the patient can visualize his/her new leg axis and initially receives additional tactile support from the therapist:
  - Three-point weight-bearing on the foot. Structure of pronatory screw connection. A build-up of pressure under the metatarsophalangeal joint of the big toe and lateral calcaneus bone is a requirement for the successful strength development of the plantar flexors
  - Positioning the knee joint to prevent medial collapse
  - Correction of the hip joint in front, sagittal and transverse level
  - Neutral position of the lumbar spine.
- Stabilization in typical walking position – overflow from the PNF concept:
  - For supporting leg activity on the side that underwent surgery:
    Starting in lateral/supine position: leg pattern flexion adduction ER contralaterally (Fig. 11.15)
    Starting in lateral/supine position: foot pattern plantar flexion pronation ipsilaterally
    Starting in lateral position with side that underwent surgery open: pelvic pattern in anterior elevation
  - For swing leg activity on the side that underwent surgery:
    Starting in lateral/supine position: leg pattern extension abduction IR contralaterally
    Starting in supine position/lateral position: foot pattern in DE inversion for further tension in flexion-adduction-ER or DE eversion for flexion-abduction-IR (symmetrically or reciprocally) ipsilaterally
    Starting in supine/lateral position/seated: ipsilateral arm pattern in extension-abduction-IR.
- Strengthening the pelvic and leg muscles from lateral position, prone position, supine position: PNF extended and bent pattern with resistance from different positions. **Cave:** No rotation in knee joint!
- PNF with resistance (but not distally!) from various positions, no rotation in the knee joint.
- Oblique vastus medius muscle training (perception, tactile stimuli), e.g., dorsal extension + supination (Fig. 11.16).
- Dynamic training of core control or core and foot stability.
- Stretching and independent stretching of shortened muscles. **Cave:** Only at the end of the phase at the earliest, as high static components have an impact on the cartilage!

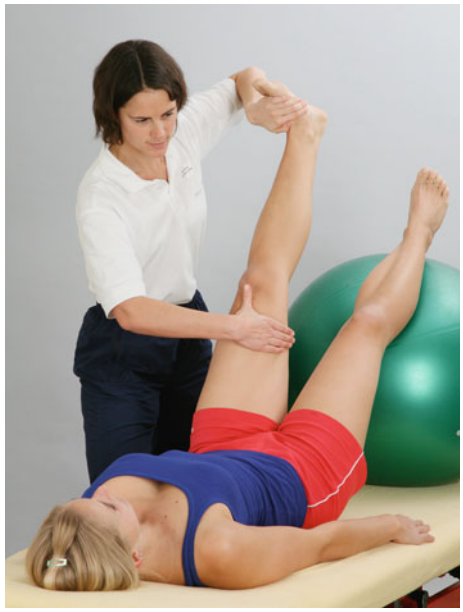

Fig. 11.15 Stabilization training in typical walking positions for supporting leg activity on the side that underwent surgery: Starting in lateral/supine position: leg pattern flexion adduction ER contralaterally

Fig. 11.16a,b Controlling via PNF foot pattern in DE and supination

Fig. 11.17 Gyrotonic: frog preparation

- Independent exercises only where activity is permitted: wall slides in supine position with feet against the wall, wiping movement while sitting; foot on slippery towel and thereby mobilization into flexion and extension in closed system.
- Gyrotonic: leg axis training with pressure relief (Fig. 11.17).
- Exercise pool: stabilization and mobilization exercises.

In the event of arthrolysis

- Carpet slides against the wall (wall slides, eccentric stabilization).
- Step-ups, initially under partial load.
- Knee bends within maximum possible range of motion (within pain-free range on the side that was operated on).

In the case of capsular/ligament reconstructions/ endoprosthetics/transposition osteotomies

- Closed system exercises, e.g., in the Redcord® system.
- Strengthening the popliteus muscle in its function as dorsal capsule tensioner: flexion + internal rotation in knee joint.
- Medial collateral ligament stabilization through strengthening of the adductors and semimembranosus muscle.
- Exercising co-contraction (ischiocrural muscles + quadriceps femoris muscle = simultaneous tensioning at approx. 20° flexion in the knee joint).
- Strengthening synergies:
  - ACL: Ischiocrural muscles
  - Posterior cruciate ligament: quadriceps femoris muscle.
- Beginning knee-bends 20°–50° and 40:60 – (injured/healthy) load:
  - Working on pressure-bearing points of the foot
  - Leg axis training:
    Starting position: sitting or half sitting in conjunction with upper extremity using a Vitality® band. Initially static stabilization, then dynamically as raise. Also on unstable equipment such as balloons, balance boards, etc.
- Pelvic pattern in closed system (lateral position, supine position, half-seated position) (Fig. 11.18).
- Coordination training under relaxation or partial load.
- Strengthening the pelvic and leg muscles from lateral position, prone position, supine position.
- Knee-bends with relief of pressure with small range of motion (Fig. 11.19a).

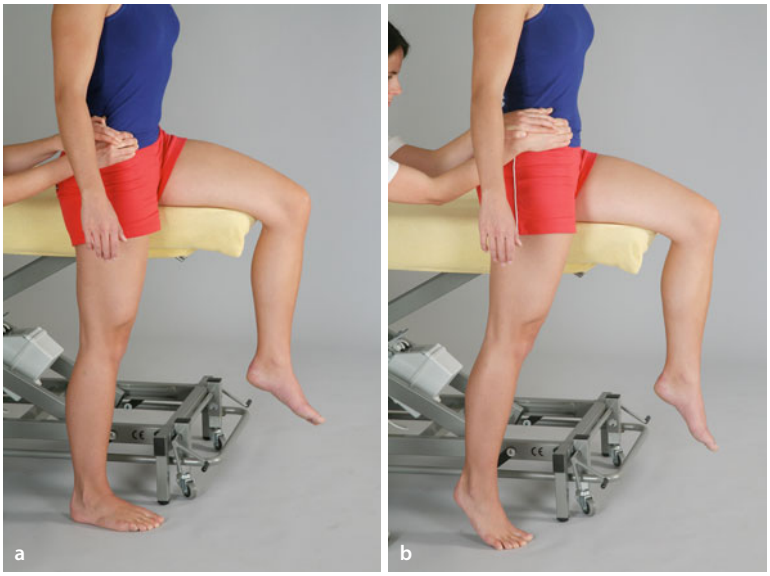

Fig. 11.18a,b Pelvic pattern in anterior elevation from half-seated position

Fig. 11.19 **a** Knee-bends with relief of pressure with small range of motion, **b** Strengthening of gastrocnemius muscle, soleus muscle, popliteus muscle, peroneal muscles, gluteal muscles, thigh muscles

- Strengthening of gastrocnemius muscle, soleus muscle, popliteus muscle, peroneal muscles, gluteal muscles, thigh muscles on various support surfaces (balancing board, balance board, mat) (Fig. 11.19b).
- Leg bends within a pain-free range with low range of motion (flexion/extension: 60°/20°/0°) on the side that was operated on.
- Improving core stability.

Gait

Practical tip

Developing gait

- The walking cycle is divided into sequences, and the individual movement components are performed in isolation.
  - Example: Should the eccentric decrease in quadriceps activity not occur during the transition form the terminal stance phase to the pre-swing stance phase, the therapist can initially only exercise the "falling" of the knee joint from the extension into flexion (until the thigh is at the same height). This is followed by the toe-off section.
- This part is then integrated into the overall movement process
  - In the example: composition of the entire swing leg phase.
- Ascend step with step-to-step technique: healthy leg in front when ascending, injured leg in front when descending.
- Learning four-point or three-point gait – depending on load guidelines and while observing leg axis and posture.
- Training the rolling phase.
- Controlling stair climbing with step-to-step technique.
- Load control on the force measurement plate.
- Posture control.
- Everyday activities: training getting into and out of the therapy car.
- Therapy garden: walking on different surfaces, slanted planes, inclines (Fig. 11.20).

Requirements for walking without crutches

- Gait without evasive movements
- Stabilization of the pelvis (e.g., no Trendelenburg gait)
- Pain-free walking
- No medial collapse
- Even leg length

Physical measures

- Manual lymph drainage.
- Compression bandage.

Fig. 11.20 Therapy garden: Walking on different surfaces, slanted planes, inclines

- CTM: arterial leg zone, venous lymphatic vessel area, extremity.
- Pneumatic pulsation therapy: regulation and relaxation of muscle tone through
  - Loosening of tissue compressions.
  - Activation and increase of lymph flow
  - Stimulating blood circulation, including in deep areas of tissue.
- Cryocuff – mild cooling and electrotherapy to promote local resorption, e.g., diadynamic currents.
- Acupuncture massage:
  - Ventral: stomach-spleen-pancreas-meridian
  - Lateral: gall bladder meridian
  - Dorsal: bladder meridian
  - Medial: kidney and liver meridian.
- TENS.
- Electrostimulation: at least 1.5 hours per day.
- Hot rolls on the sole of the foot to stimulate foot reflexology.
- Cryokinetics: intermittent brief application of ice pack (cooling for 20 seconds, then activating the extremity until the skin is warm again, then repeat the cooling; 3-4 intervals).
- CPM movement cast: six hours per day with repeated applications.

Cave: In the case of meniscus treatment:
- **Shearing forces arise in particular in deep flexion positions in combination with rotation**
- **No deep squatting for three months in order not to exert unnecessary stress on the meniscus**

- **In every treatment, the pelvic position should be controlled regularly and treatment should be provided where indicated: e.g., ilium rotation, up-slip or down-slip; inflate and outflare problems, sacrum misalignments.**
- **The visceral connections must also be considered. Anterior ilium rotation: Iliacus muscle – pelvic organs; ilium pelvic rotation: psoas muscle – abdominal organs.**
- **Do not overstrain patient, include sufficient regeneration phases.**
- **Controlling leg length: potential anatomical or functional difference in leg length.**
- **Consider orthopedic or podo-orthesiological insole treatment.**

Criteria for strain restrictions
- 24 hour pain behavior
- Swelling/effusion
- Redness
- Overheating
- Reduction or stagnation of range of motion
- Reduction or stagnation of strength

Medical training therapy

- General accompanying training of the core and the upper extremity: pilates (Fig. 11.21), lat pull (Fig. 11.22), dip trainer, rowing, bench presses (Fig. 11.23), abdominal and back training (Fig. 11.24).

Endurance training

- Three-point ergometer without the use of the extremity concerned insofar as load-bearing is not permitted (Fig. 11.25a). Potentially with shortened crank for TB (Fig. 11.25b).
- Ergometer training: 1 × 10 up to 2 × 15 mins with low load at 20–50W, potentially shortened crank.
- Gait training.

Sensorimotor function training

- Pilates reformer training in the form of leg presses with 10-15kg weight (Fig. 11.26).
- Working out the leg axis within the permitted load and range of motion:

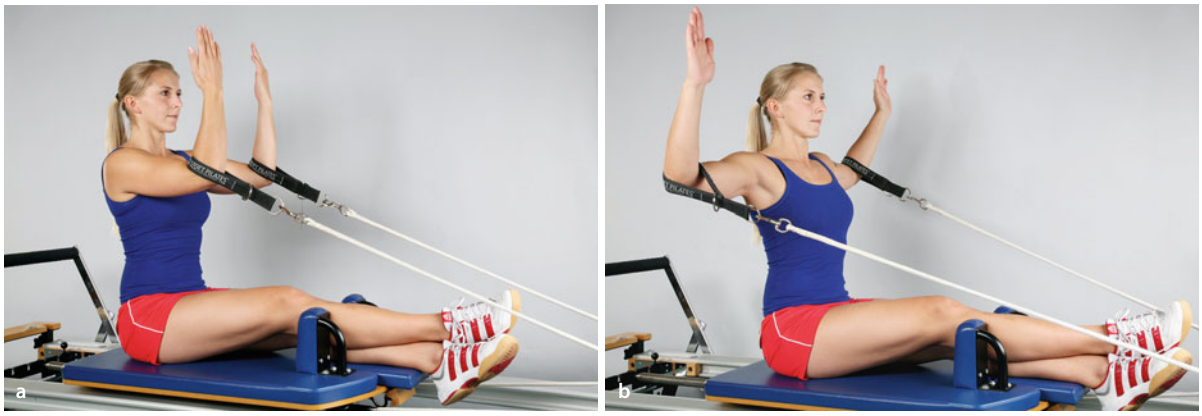

Fig. 11.21a,b Pilates Reformer Open Elbows

Fig. 11.22 Lat pull

Fig. 11.23 Bench presses

- Mini knee-bends on both legs up to max. 60° flexion in the knee joint
- Leg presses with 10-15kg, controlling movement using the healthy leg.

- Developing stabilization while standing on fixed, then on unstable surfaces using Dotte swing, balance board, Posturomed, Balancepad:
  - Bearing weight standing parallel on both legs from a high (extended) knee angle
  - Bearing weight while stepping forwards
  - Cable pulley: guiding contralateral leg (Fig. 11.27).

Sensorimotor function training principles

- **Static training:**
  - Load time: 5–30 seconds
  - Number of repetitions: 10
  - Number of exercises: 1–4
- **Dynamic training:**
  - Number of repetitions: 10–20
  - Series: 1–3
  - Number of exercises: 1–4

In sensorimotor training, the quality of the execution of the movement is of great importance.

Fig. 11.24 **a** Back exercises using the cable pulley, **b** Training abdominals and back using barbell bar

Fig. 11.25a,b Three-point ergometer without use of the extremity concerned (**a**), in the case of TB with shortened crank (**b**)

Note:
- Loss of active stabilization (foot control, leg axis, core stability)
- Coordination disorder
- Muscle tremors
- Decrease in concentration.

Firstly static stability, then building up dynamic stability. As far as possible, always look for a transfer to everyday situations (lifting something).

Fig. 11.26 Pilates reformer training in the form of leg presses with 10-15kg

Fig. 11.28 Strength endurance training, adjusted to plans; focus on local stabilizers

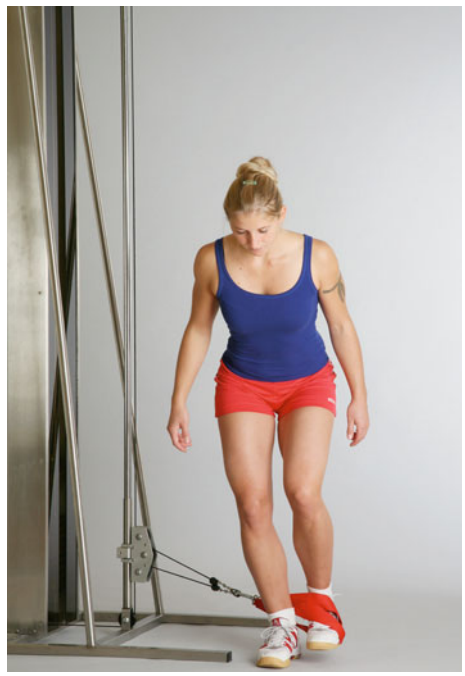

Fig. 11.27 Cable pulley: Controlling contralateral leg

The load or the work of the quadriceps femoris muscle to be performed depends heavily on the position of the upper body. An upright upper body position leads to a greater load arm than an inclined upper body. The torso should therefore be brought forwards to begin with.

Strength training

- Intramuscular activation via isometry.
- Strength endurance training, adjusted to plans; focus on local stabilizers: 4 × 20 (–50) repetitions within the completely pain-free range! (Fig. 11.28)
- Overflow via the contralateral side (strength endurance training; 4 × 20 reps) starting in supine position: cable pulley exercises in PNF diagonal patterns.
- Training hip joint stabilizers:
  - Flexion/extension (in supine position, heels flat on the floor with hips in flexion; leg lifts in prone position on the bench)
  - Abduction/adduction (standing with lateral fixation, foot on a tile, slide sideways)
  - Slides on slideboard or Flowin® mat (Fig. 11.29)
  - Rotation (rotation disc, affected leg on the disc, rotating the hip joint between around 10 and 11 o'clock left/1 o'clock and 2 o'clock right, without load, stable pelvis (**Cave:** Surgical access).
- Training knee joint stabilizers:
  - Flexion (seated starting position: Vitality® band fixed behind the heel from in front, from stretch position slide the heels on a tile underneath on the floor into flexion position) (Fig. 11.30)
  - Extension (stretching via supported position from 20° flexion into full extension, without load). **Cave:** Pay attention to retropatellar symptoms, not in the case of retropatellar cartilage reconstruction, MPFL or tuberositas treatment
  - Flexion/internal rotation (popliteus muscle, standing with leg hanging freely, 2kg – 5kg weight band on foot, but kicks with rotation components)
  - Leg press, lowest load, leg axis training with a focus on eccentric training (slowly and controlled). **Cave:** Not in the case of meniscus and cartilage treatment
  - Step ups on aerobic step. Leg on step, weight on back leg, then shifting weight to the front leg (activation of quadriceps femoris muscle, potentially using a biofeedback device). **Cave:** Not in the case of meniscus and cartilage treatment!

Fig. 11.29 Slides on the Flowin® mat

Fig. 11.31 Plantar flexion in seated starting position: Vitality® band around the forefoot, attach with the hands, slow plantar flexion and eccentric slackening until in neutral position

Fig. 11.30 Flexion in seated starting position: Vitality® band fixed behind the heel from in front, from stretch position slide the heels on a tile underneath on the floor into flexion position

Fig. 11.32 Calf muscle training

- Training ankle joint stabilizers:
  - Plantar flexion in seated starting position: Vitality® band around the forefoot, attach with the hands, slow plantar flexion and eccentric slackening until in neutral position (Fig. 11.31)
  - Dorsal extension in seated starting position: Vitality® band attached from the front (e.g., on wall bars or table leg), lower leg slightly supported, then dorsal extension against traction from the Thera-Band
  - Calf muscle training (Fig. 11.32).

11.3 Phase III

Goals (in accordance with ICF)

Goals of phase III (in accordance with ICF)

- **Physiological function/bodily structure:**
  - **Improvement in functions affecting sensorimotor function**
  - **Improving joint mobility**
  - **Optimization of core, pelvic and knee stability**

- **Restoration of muscular strength**
- **Optimization of a coordinated movement pattern along the kinematic chain during movement**
- Optimization of the gliding ability of neural structures

- **Activities/participation:**
  - Developing ergonomic posture and movements in everyday routine, at work, during sport
  - Resumption of professional activities
  - Active participation in the life of the community/family life

11.3.1 Physiotherapy

Patient education

- Discussing the content and goals of treatment with the patient.
- Information regarding return to work and to sport.
- Informing the patient about the restrictions they will still have:
  - In the case of **meniscus sutures**, no load above 90° knee flexion for three months post-op (no deep squatting)
  - **Patella treatment:** fourth month post-op – begin running training on even ground, cycling, front crawl swimming (medial patellofemoral ligament (MPFL) without dysplasia after sixth week post-op.)
  - In the case of **transposition osteotomies:** beginning running training on even ground from approx. 16th week post-op, no jumping until 16th week post-op.
- Ergonomic advice for everyday life, work and sport.

Improving mobility

- Mobilization of the patella; with/without compression, static and with movement.
- Combined compression, mobilization or oscillation technique (3-5 sets with 20 reps. Active breaks through active-assisted movement of the joint; axial compression, later with mobilization) (Fig. 11.33).
- No cartilage involvement: passive mobilization through manual therapy (MT):
  - Traction with oscillation in rest position and pre-positioning
  - Dynamic mobilization (controlling biomechanics)
  - Improving the IR and ER in the knee joint.
- Active and passive joint mobilization (**Cave**: Cartilage or meniscus treatment):

Fig. 11.33 Combined compression, mobilization or oscillation technique (3-5 sets with 20 reps. Active breaks through active-assisted movement of the joint; axial compression, later with mobilization)

  - Actively assisted movement of the knee joint within the pain-free range
  - Independent mobilization with simultaneous leg axis training, e.g., via wall slides
  - Mobilization of the patella (4 directions)
  - Careful traction (level I–II) with and without movement (not in the case of attached types of prostheses)
  - Mobilization under compression.
- Mobilization of the neighboring joints: pelvis, lumbar spine, distal and proximal tibiofibular joint depending on findings.
- Mobilization of neural structures:
  - Straight leg raise (SLR)
  - Prone knee bend (PKB) for saphenous nerve (knee joint extension + hip extension/abduction/ER + foot EV/DE or plantar flexion)
  - SLR
  - Slump.
- Manual therapy: depending on findings, dorsal femur for extension in knee joint (Fig. 11.34).
- Soft tissue treatment:
  - Neighboring muscles: ischiocrural muscles, psoas muscle, iliac muscle, iliotibial tract, adductor group, pelvic trochanter muscles (primarily piriformis muscle), gluteal muscles, quadratus femoris muscle, soleus muscle, gastrocnemius muscle, popliteus muscle, long muscles of the foot (tibialis anterior muscle is detached in the case of high tibial adjustments) through:

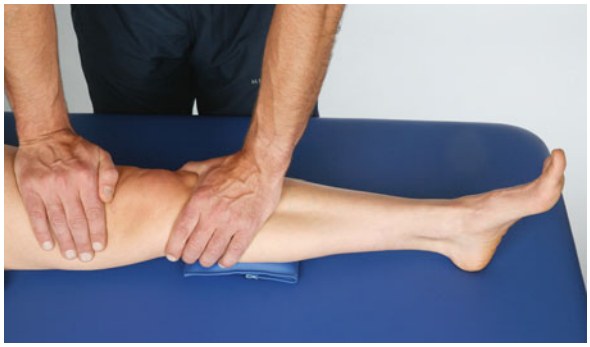

Fig. 11.34 Manual therapy: dorsal femur for extension in knee joint

Fig. 11.35 Treatment of myofascial structures: superficial back and front lines

INIT
Strain-counterstrain
MET: five second isometric contraction – relaxation – stretching the muscle. Repeat five times or until no further extension occurs
Relaxation techniques from the PNF concept (hold relax and contract relax for antagonist inhibition, rhythmic stabilization)
Functional massage
Subsequently, potential stretching of the shortened structures (hold stretch position for at least one minute)

- Treating ligament structures through cross-fiber massage on: meniscofemoral and meniscotibial ligaments, suprapatellar recess, collateral lateral ligament, patellar ligament
- Fascia treatment through pressure and release techniques on the pelvis and the lower extremity, e.g., long plantar ligament, fascia cruris, lateral thigh fasciae, ischiatic fascia on the thigh and lower leg, fascia lata, plantar fascia
- Treatment of the myofascial structures: superficial back and front lines, (Fig. 11.35) spiral line and lateral line.

- Active and passive joint mobilization:
  - Active movement of the knee joint within the pain-free range from various starting positions
  - Independent mobilization and leg axis training via wall slides
  - Manual mobilization of the patella (4 directions)
  - Treatment of patella problems
  - Improvement in the timing of the vastus medialis oblique muscle (VMO should be activated earlier and more strongly than the VLO along the entire path of movement in eccentric and also concentric exercise)
  - Subsequent integration into the overall muscle synergies (supinators, adductors, gluteal muscles)
  - Leg axis training in order to better control the dynamic Q angle (less valgus, less medial rotation of the lower leg)
  - Stretching or extension to tight support structures (retinacula, iliotibial tract, VLO, patella tendon)

Patella positions

- **Glide:** the patella shifting sideways, usually laterally (may also slide medially in the case of flexion)
- **Tilt:** tilting the patella sideways (medial and lateral patellofemoral joint line should be the same size)
- **Rotations:** ER – the lower pole lies laterally to the upper, IR – lower pole lies medially to the upper
- **A/P tilt:** tilting the patella on sagittal level – the lower pole is tilted in posterior direction in comparison to the upper

- Activation of the quadriceps femoris muscle: promoting sliding between the surface and deep layer of the suprapatellar recess to prevent adhesions.
- Controlling joint mechanism of extension and flexion: rotation mobilization only following bone fusion (wait for radiological examination) of the osteotomy line.
- Automobilization for extension and flexion: e.g., shifting weight from quadrupedal position with buttocks in zen pose without swaying the pelvis.
- Improving tissue displacement in the surgical area.
- Checking the cause-effect chain (see appendix for examples).
- Automobilization for extension and flexion: e.g., starting in standing position: foot is rested on a chair or stool. By shifting weight forwards, a shift in pivot takes place, which expands the knee flexion.
- Mobilization of neural structures with techniques: PKB (Fig. 11.36), SLR or Slump.
- Meniscus mobilization (Fig. 11.37).

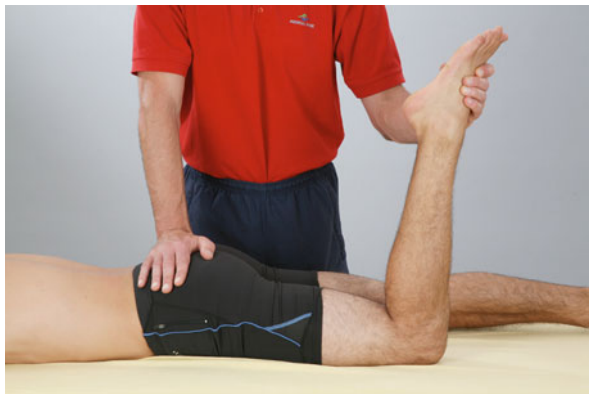

Fig. 11.36 Mobilization of neural structures with PKB

Fig. 11.37a,b Mobilization of the lateral meniscus

Practical tip

Meniscus mobilization

- **General:** Extension and flexion take place on meniscofemoral level and rotation on meniscotibial level. In the case of IR/ER of the tibia, the menisci follow the condyles of the femur.
- For the **lateral meniscus:** move knee and hip in flexion + knee in internal rotation.
- During mobilization, the knee always remains in varus position(!) – move from the flexion +IR + varus position in extension + ER + varus position. Full extension is held for a short period.
- For the **medial meniscus:** flexion + ER + valgus → extension + IR + move valgus

Following immobilization, the joint cartilage displays significantly diminished resilience. Shearing movements should be avoided as much as possible.

Regulation of vegetative and neuromuscular functions

- Treatment of tender points:
  - Strain-counterstrain technique: Apply pressure to the point of pain or to the most hardened area of the muscle. Relax the tissue by moving the neighboring joints until the pain subsides or the tissue has noticeably relaxed. Hold this position for 90 seconds and then passively(!) return to the starting position.
- Treatment of trigger points:
  - INIT: Apply ischemic compression to the trigger point through pressure, until the pain lessens. Should there be no change in pain after 30 seconds, relieve the compression and apply a potential release technique, i.e. converging the structures until release. Then seven seconds of isometric tensing and stretching of the muscle.

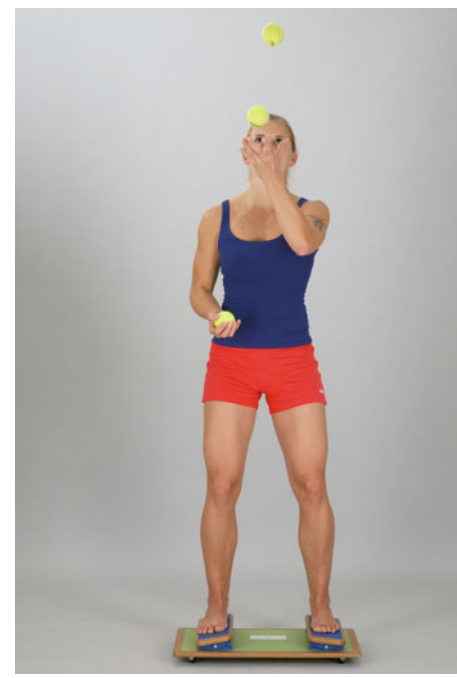

Fig. 11.38 Coordination-promoting exercise on the MFT Sport Disc

Fig. 11.39a–d Stabilization exercises on one or both legs with obstruction. **a** Seesaw board, **b** Gymstick, **c** Balance board, **d** Stabilization pad

Improving sensorimotor function

- Coordination-promoting exercise on various unstable support surfaces:
  - More advanced option: with closed eyes or additional tasks (Fig. 11.38)
  - Raising until standing on one leg.
- Stabilization exercises on one or both legs with obstruction: seesaw board (Fig. 11.39a), gym stick (Fig. 11.39b), balance board (Fig. 11.39c), stabilization cushion (Fig. 11.39d), platform.
- Perception of balanced standing position while standing bipedally (calcaneus bone and metatarsal bones touching), with eyes closed.
- Biofeedback, e.g., via surface EMG (Fig. 11.40)
- Closed system exercises, including on unstable surface with additional tasks. Order:
  - Eyes open
  - Looking away
  - Eyes closed

  (Fig. 11.41).
- Reactive training of the supporting leg phase/standing on one leg.
- Tai chi for physical perception, static forces in the foot, 3D screwed connection of the leg axis.
- Increasing intensity of closed system isokinetics to improve intramuscular coordination (alternatively shuttle, reformer).
- Reactive single leg stabilization (e.g., lunge).

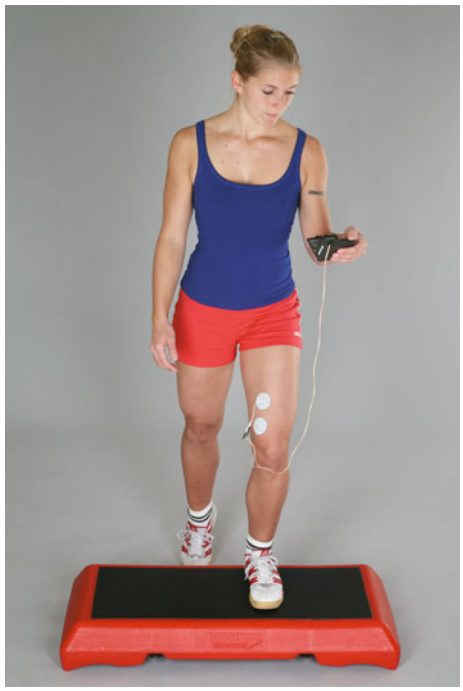

Fig. 11.40 Biofeedback via surface EMG

Fig. 11.42 Eccentric quadriceps training: Movement transition from standing → 1/2 half kneel via pelvic pattern (PNF)

- Rotational control on instable/stable support surface.
- Travelling around a course.
- Acceleration and braking training.
- Eccentric quadriceps training in functional starting position, e.g., movement transition from standing → half kneel via pelvic pattern (PNF) (Fig. 11.42).

Stabilization and strengthening

- Meniscus and cartilage treatment: wall slides (eccentric stabilization).
- Intensive strengthening of the foot and lower leg muscles, e.g., Nurejew (Fig. 11.43a,b), soleus muscle (Fig. 11.43c), gastrocnemius muscle (Fig. 11.43d).
- Step-ups initially under partial load (Fig. 11.44),

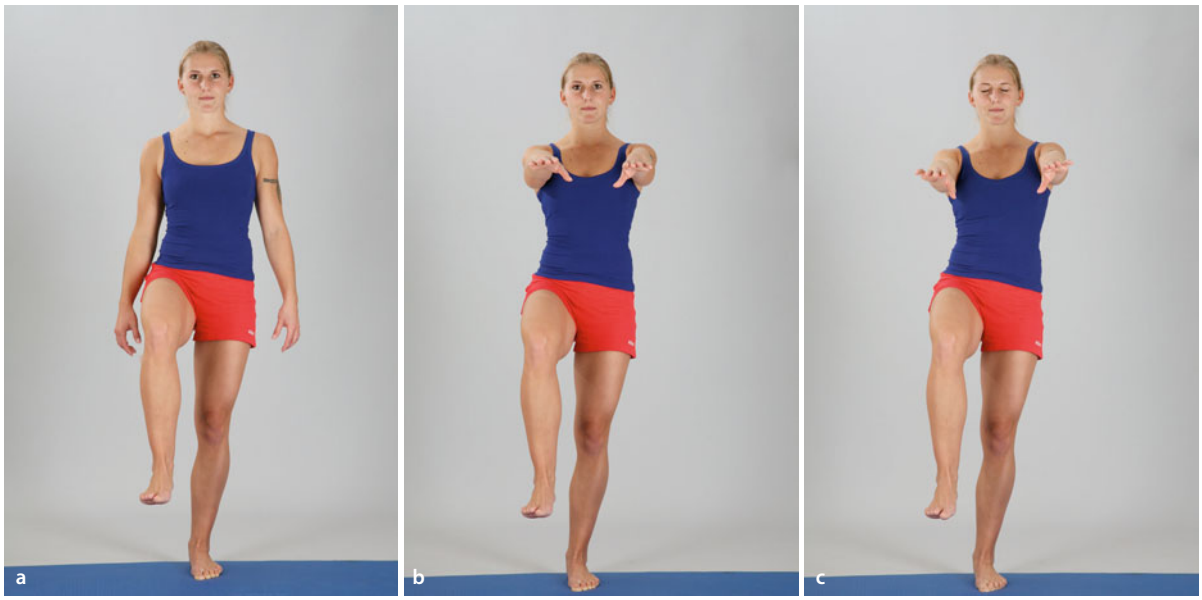

Fig. 11.41a–c Closed system exercises with additional tasks

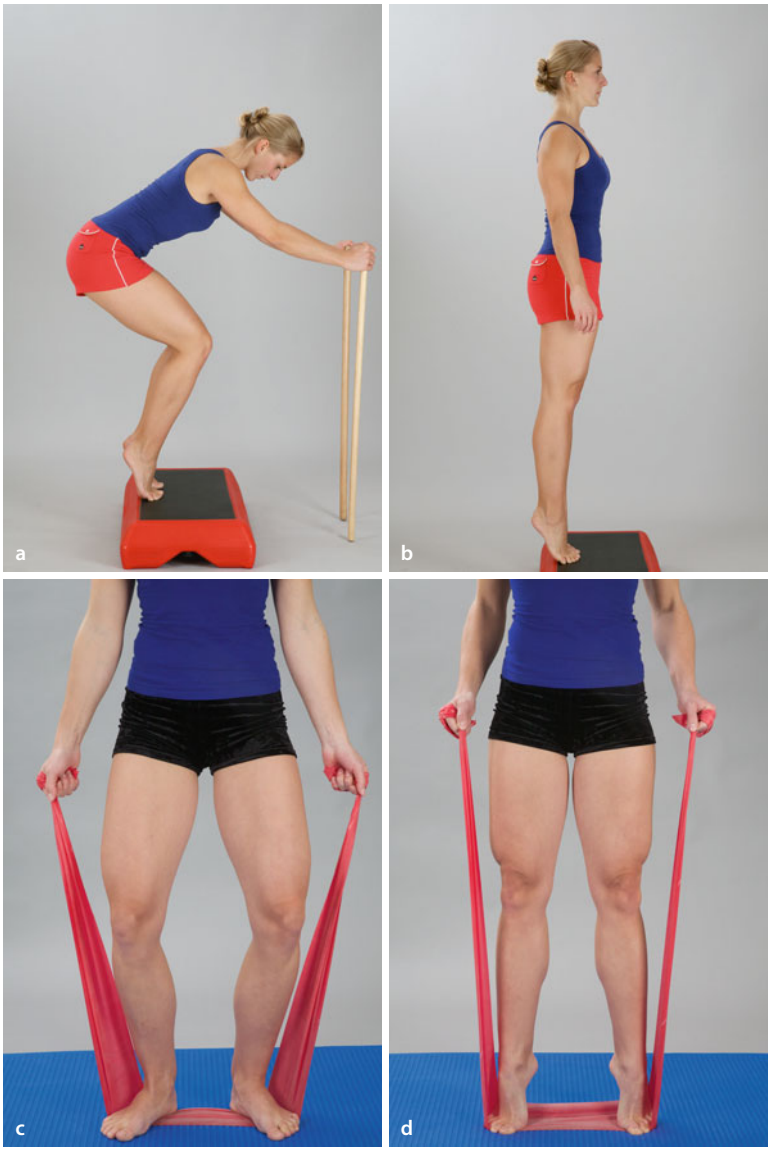

Fig. 11.43a–d Intensive strengthening of the foot and lower leg muscles. **a,b** Nurejew, **c** Soleus muscle, **d** Gastrocnemius muscle

then increasingly raise the load until full load with additional weight: cranial ventral shift in body weight while monitoring body stability.
- Dynamic one-leg stabilization: lunge with leg that underwent surgery forwards; shifting center of gravity caudally and cranially while controlling stability. Maximum knee flexion 60°!
- Stabilization with traction device (leg that underwent surgery on balance board, seesaw board, foam material), on one or both legs.

In the case of capsule/ligament reconstructions

- Increasing stabilization training; starting with jumping under partial load.
- Intensive (**Cave:** Pain) isometric quadriceps exercises from sitting, 70° knee flexion 8–10 seconds tension/15 seconds rest.
- Collateral lateral ligament reconstruction: Strengthening the adductors and semimembranosus muscle (flexion and adduction).
- Impulse and reaction training with resistance near the joint.
- Training vastus medialis muscle: closed chain for extension/open chain for flexion.
- Exercise with the Redcord® system to exercise the muscular chains (Fig. 11.45).
- Knee-bends: developing from 60:40 (injured/healthy) 20–60° to 50:50 with additional weight.

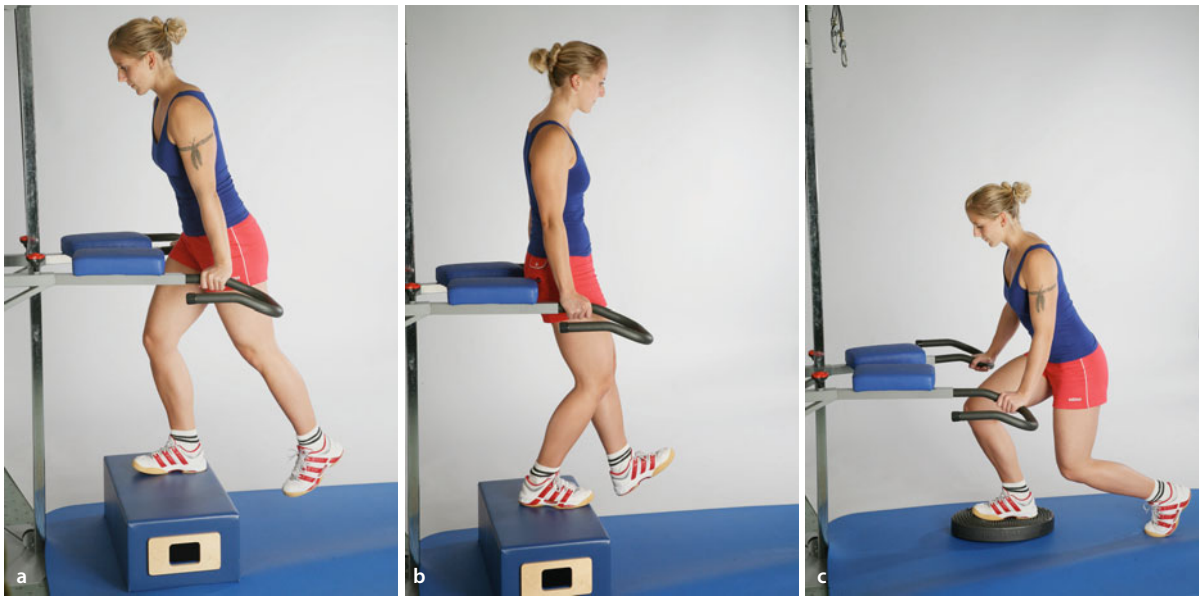

Fig. 11.44 Step-ups under partial load: Cranial ventral shift in body weight while monitoring body stability

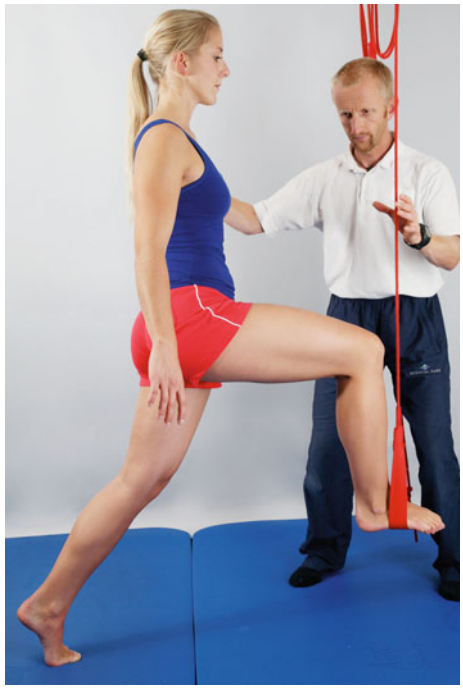

Fig. 11.45 Training with the Redcord® system to exercise the muscular chains

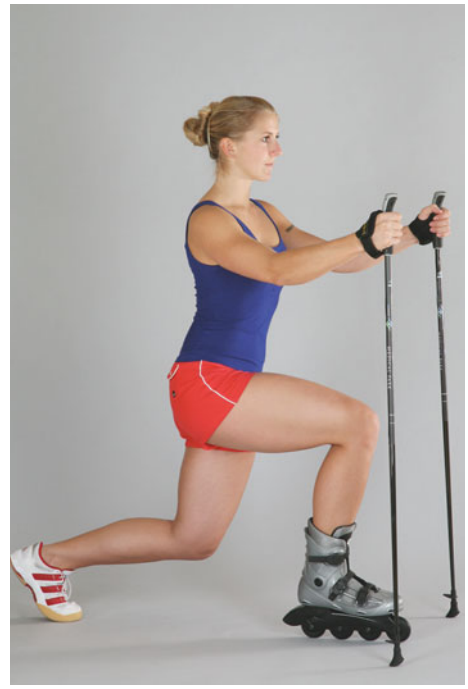

Fig. 11.46 Dynamic stabilization with increased load: Lunges on inliner

- Leg axis training.
- Strengthening the muscle chains of the lower extremity: Gluteus maximus muscle on the right and latissimus dorsi muscle on the left.
- Dynamic stabilization with increased load (Fig. 11.46).
- Intensive strengthening of the foot and lower leg muscles.
- Stabilization training on the mat.
- Beginning one-legged stabilization exercises (Fig. 11.47).
- Walking on the spot against Vitality® band (or life-line).

Fig. 11.47a,b One-leg stabilization exercises. **a** Step-down with additional weight, **b** Step-up with additional weight

Fig. 11.48a,b Stabilization with core involvement

- Stabilization exercises on traction equipment: injured leg on the gyroscope, trampoline.
- Start with one-leg knee-bends (**Cave:** Pain).
- Stabilization with core involvement (Fig. 11.48).
- Strengthening the pelvic/leg musculature in synergetic chains.
- Core strengthening with involvement of the lower extremity (Fig. 11.49).
- Dynamic exercising, beginning with partial load, with various surfaces (mat training), ball cushion, MFT, balance board, trampoline, Swiss ball (Fig. 11.50a), Haramed (Fig. 11.50b), Posturomed (Fig. 11.50c).
- Developing dynamic stability in supporting and free leg phase, potentially beginning with parallel bars.
- Strengthening/improving innervation in the muscular chains by exercising using the Redcord®

Fig. 11.49 Core strengthening with involvement of the lower extremity on Swiss ball

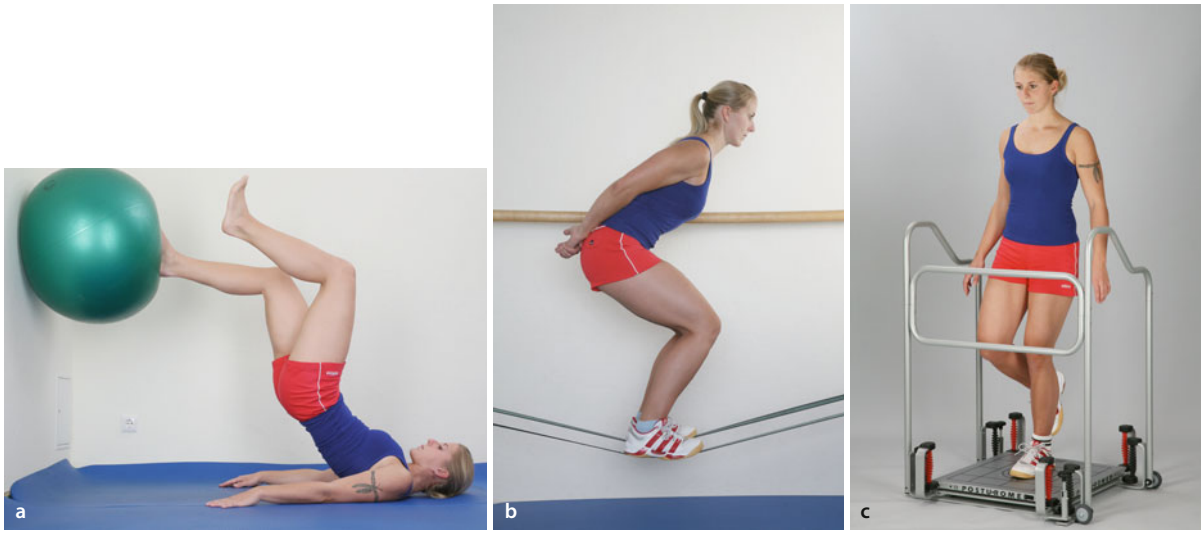

Fig. 11.50a–c Dynamic exercise with **a** Swiss ball, **b** Haramed, **c** Posturomed

system (frontal support on the forearms with legs suspended).
- Reactive training of the supporting leg phase/standing on one leg (pivot, fixed supporting leg, striking leg in front, to the side, behind).
- Pilates: use of the reformer (Fig. 11.51).
- Strengthening the popliteus muscle (dorsal capsule tensioner): flexion + internal rotation.
- Training requirements for everyday activities.
- Exercise pool: coordinative-reactive exercises; aqua jogging.

Fig. 11.51 Pilates: Reformer front split

Gait

See also "Improving sensorimotor function".
- Leg axis training:
  - Develop three-point weight-bearing on the foot
  - Positioning the knee joint to prevent medial collapse
  - Correction of the hip joint in front, sagittal and transverse level
  - Neutral position of the lumbar spine.

Pathology of medial collapse

- Collapse of the longitudinal arch
- Medial rotation of the tibia and caudal tipping
- Medial rotation of the femoral condyles in the knee joint
- Adduction/external rotation or abduction of the pelvis
- Lateral flexion to the opposite side in the lumbar spine

- Reaction and braking test in therapy car.
- Potentially weaning off crutches.

Requirements for walking without crutches

- Walking is possible without evasive movements
- Stable leg axis: no medial collapse
- Stabilization of the pelvis (e.g., no Trendelenburg's sign)
- Pain-free walking
- As even leg length as possible

- Increasing the simulation of everyday strains (e.g., walking in the walking garden with additional tasks) with different coordination options (backwards, sideways, slowly, quickly, etc.) on different ground surfaces.
- Use of visual (mirror, floor markings) and acoustic (rhythmic tapping) aids.
- Intensification of training to improve perception, adapted to potential new strains, e.g., walking on different surfaces with visual and acoustic distractions: walking in the walking garden/walking course with
  - Holding a conversation
  - Opening an umbrella
  - Singing a song
  - Coordinative variations (backwards, sideways, slowly, quickly)
  - Differing illumination (simulation of everyday situations).
- Increasing the exercise duration on the treadmill while checking in mirror.
- Video gait analysis as feedback for the patient.
- Walking on the force measurement plate for load control: is load placed on the side that was operated on?
- Under full load, walking (1-6km/hour) or brisk walking (6-8km/hour) – no jogging.
- Walking against resistance, Vitality® band, cable pulley, e.g., life line.
- Monitoring lower leg acceleration in the terminal swing phase.

Physical measures

- Lymph drainage.
- Regeneration massage for overstrained muscle sections.
- Electrotherapy: Iontophoresis, diadynamic currents, high voltage.
- Acupuncture massage: energetic treatment of the scar.

Energy flow disruptions in the meridian system that may lead to functional disorders locally or in other parts of the body are caused by interference fields. Scars may require such interference fields.

Pay attention to regeneration times during intensive training!

- Functional measurement of the lower extremity.
- Reflexology: periosteal massage, extensive connective tissue massage.

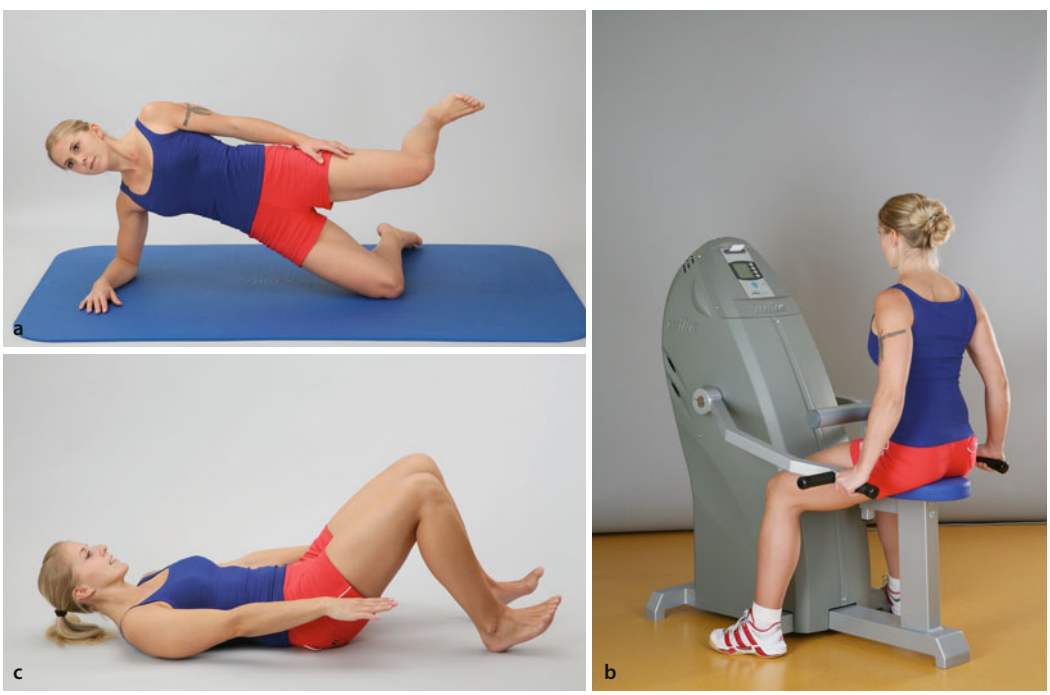

Fig. 11.52a–c General accompanying training of the core and the upper extremity: abdominal muscle training, **a** forearm side plank, **b** Dip trainer, **c** Crunches

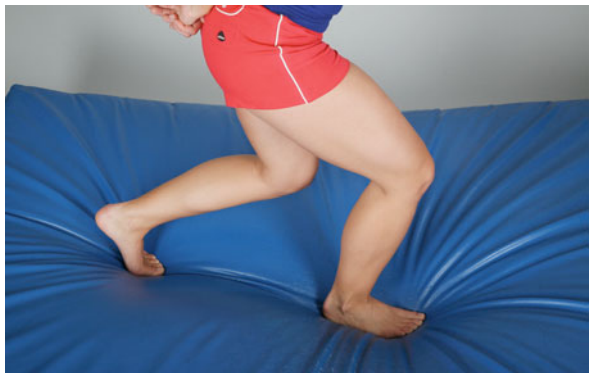

Fig. 11.53 Standing stabilization on an instable surface: mat

Fig. 11.54a,b Single-leg standing exercises under variable conditions. **a** Haramed, **b** balance board + Vitality® band

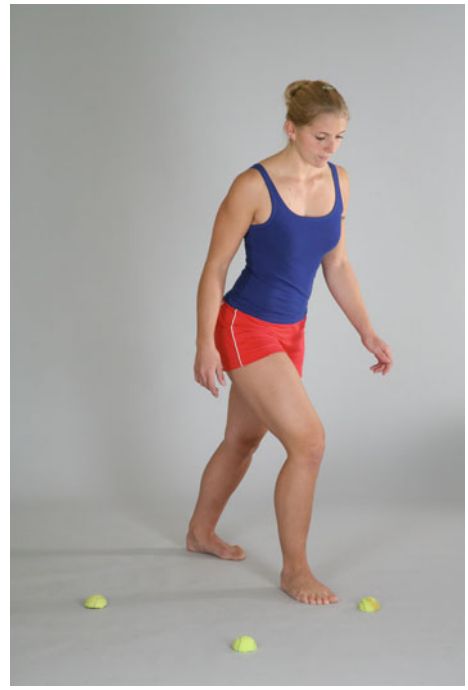

Fig. 11.55 Developing walking alphabet: step combinations from standing (stepping forwards, stepping sideways alternatively on the spot)

Criteria for strain restrictions

- 24 hour pain behavior
- Swelling/effusion
- Redness
- Overheating
- Reduction or stagnation of range of motion
- Reduction or stagnation of strength

11.3.2 Medical training therapy

- General accompanying training of the core and the upper extremity: rowing, lateral pull, bench press, dip trainer, abdominal muscle training (Fig. 11.52).
- Gait training: weaning off crutches.

Sensorimotor function training

- Developing the stabilization of the leg axis under variable conditions, including with medium loads: e.g., standing stabilization on instable surface with lateral cable pulley load, mat (Fig. 11.53).
- Single-leg standing exercises under variable conditions:
  - Bearing weight on one leg, different flexion angles: stabilization of core, leg axis, foot arch; standing on Dotte swing, rotation plate, Haramed, (Fig. 11.54) balance board + Vitality® band (Fig. 11.54b)

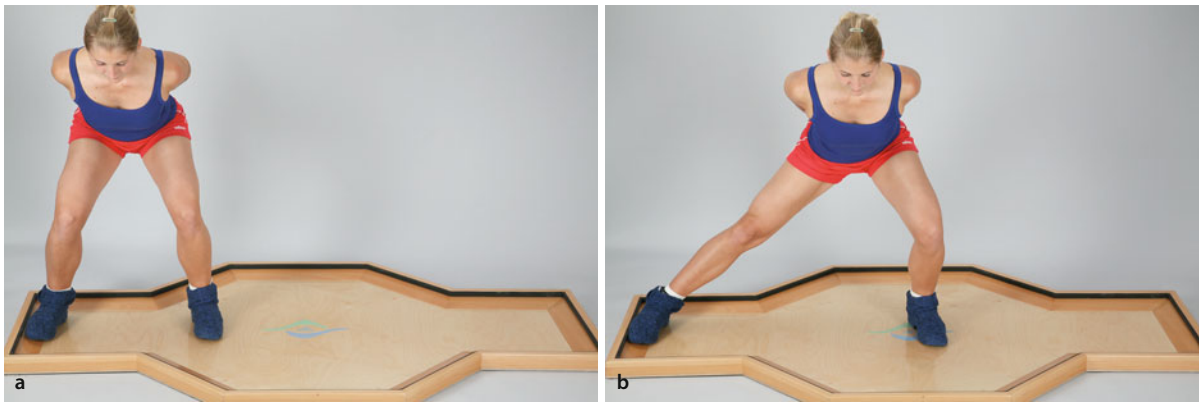

Fig. 11.56a,b Developing walking alphabet: side jumps (small jumps sideways) with brief stabilization phase on the slide mat

- Developing foot stabilization and dynamic: e.g., spiral dynamic screw connection of the foot, load distribution training of the foot in dynamic situations, e.g., stabilize on one leg in side step while complying with three-point load
- Squats within permitted range of motion on both legs or on one leg with a smaller range of motion while checking using a mirror. Preventing a medial collapse when bearing a weight.

- Developing walking alphabet:
  - Step combinations from standing (stepping forwards, stepping sideways alternating on the spot) (Fig. 11.55)
  - Ankle workout while standing: e.g., rolling from toes to heel
  - Running on forefoot with small amplitude, slowly forwards (heel constantly remains in the air)
  - Walking on a slanted plane
  - Side-steps (steps sideways with a brief stabilization phase on one leg)
  - Side jumps (small jumps sideways) with brief stabilization phase on the slide mat (Fig. 11.56).
- Training in Redcord® system: Leg axis training (Fig. 11.57).
- Training the eccentric muscle phase: e.g., step-downs from low levels (5-10cm platform), stepping down forwards, watching out for pelvic and leg axis stability, place free leg on the floor heel-first.
- Working on jumps:
  - Step-forwards with training in the landing phase and braking function (note the eccentric phase with minimum yield and further extension to standing position)
  - Two-legged jumps outwards: e.g., jumping onto level steps with soft landing.
- Stretching: Hamstrings (Fig. 11.58a), rectus femoris muscle (Fig. 11.58b).

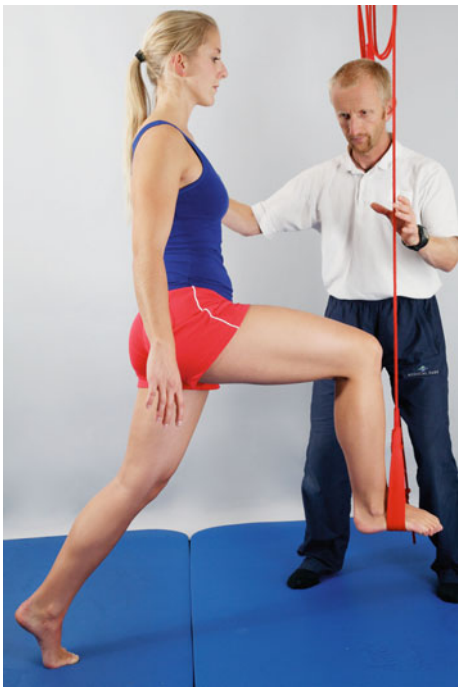

Fig. 11.57 Leg axis training in Redcord® system

- Feedback training, also with medium loads: e.g., single-leg squats on proprio-swing system.
- Sport-specific conditioning: e.g. sidestep tennis, inliner, pass basketball, ice hockey passing (Fig. 11.59a,b), ice hockey passing (Fig. 11.59c)

Strength training

- Endurance strength training, as warmup exercise for the local stabilizers, see phase II.
- Hypertrophy for general musculature, medium range of motion: 6 × 15 reps, 18/15/12/12/15/18; as pyramid. (**Cave:** Within the completely pain-free range)!

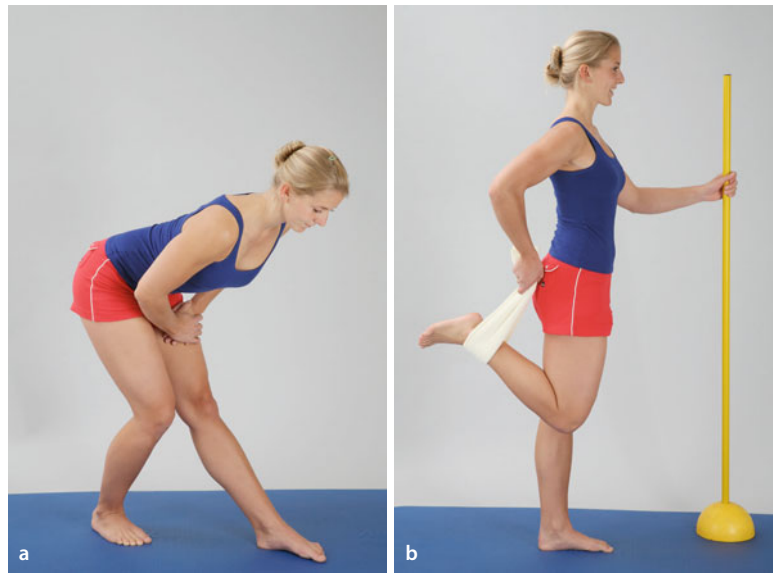

Fig. 11.58a,b Stretching **a** hamstrings, **b** rectus femoris muscle

Fig. 11.59a–c Sport-specific conditioning. **a,b** Pass basketball, **c** Ice hockey passing

- Knee-bends: Leg presses, reformers, shuttle, squats and variants: Squat (Fig. 11.60a,b), front (Fig. 11.60c,d), squat Lunges (Fig. 11.60e,f).
- Step-ups (Fig. 11.61).
- Hamstring curls.
- Calf training (**Cave:** PCL reconstruction).
- Ab/adductor training.
- Training the core and gluteal musculature (good morning, Fig. 11.62, rowing bend over, barbell rowing).
- Working on jumps (not in the case of meniscus or cartilage treatment):
  - Jump – land
  - Jump – open eyes = land
  - Close eyes – jump – land
  - On two legs – on one leg
  - With stretch 1/4, 1/2, 3/4, 360°
  - Landing on unstable surfaces
  - Step-forwards with training in the landing phase and braking function

Fig. 11.60 Knee-bends. **a,b** Hack squats, **c,d** Front squats, **e,f** Squat lunges

- Two-legged jumps outwards (e.g., jumping onto level steps)
- Cross jumps
- Forwards and backwards over or on a line (Fig. 11.63)
- Side-jumps
- Zigzag jumps.

Endurance training

- Ergometer training 20–30 mins with increasing duration and wattage depending on physical condition.
- Treadmill exercise: walking uphill 10–20 mins 10% incline at 3-5km/h.

Therapeutic climbing

- Initial stabilization from deep joint position in vertical wall area with traction support: frontal standing, hands grabbing above shoulder height, raising out of deep angle position by stepping, with arms supporting the movement.
- Approval of rotational starting pattern (as above, but from slightly wound position).

Fig. 11.61 Step-up with barbell, **a** Starting position, **b** End position

Fig. 11.62 Training the core and gluteal musculature: Good morning

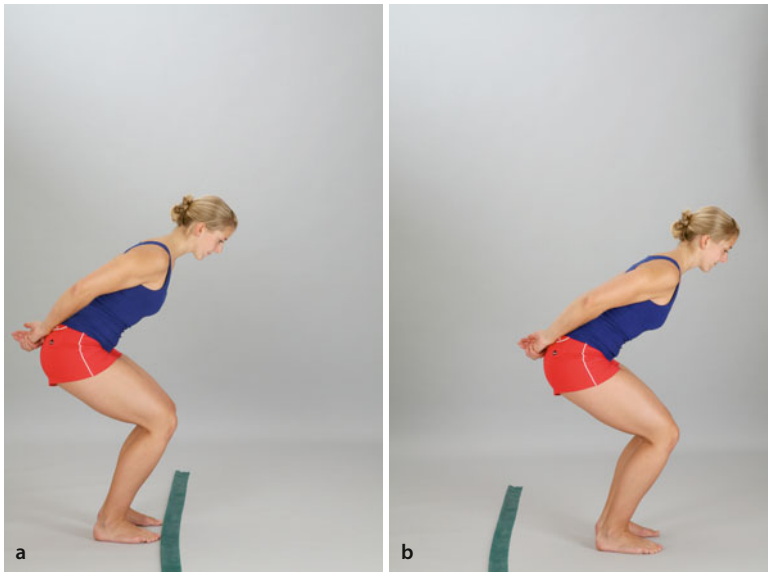

Fig. 11.63a,b Jumping forwards and backwards over a line

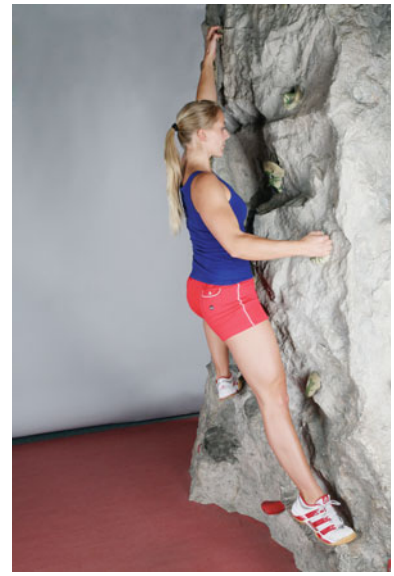

Fig. 11.64 Step alternating training in positive wall area: arms hold two handles in place, legs alternate on different steps

- Step alternating training in positive wall area (arms hold two handles in place, legs alternate on different steps, determination of certain movement consequences (moves) (up/down, side to side) (Fig. 11.64).

11.4 Phase IV

The objective of training in phase IV lies in the patient's ability to resume sporting activities. The sports-therapeutic content of rehabilitation phase IV following knee joint operations is summarized for the entire lower extremity in ▶ Section 15.4.

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Cartilage treatment on the knee joint: Surgical procedure/aftercare

Andreas B. Imhoff, Knut Beitzel, Knut Stamer, Elke Klein

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12.1 Surgical techniques for cartilage treatment

12.1.1 Microfracture

Indication

- Focal, purely chondral defects (level II-IV in accordance with Outerbridge).

Surgical method

- Primary diagnostic arthroscopy via standard portals to assess the existing pathology.
- Debridement with sharp curette.
- Microfracturing prick until droplets of fat emerge. (Fig. 12.1)

Aftercare

Table 12.1 provides an overview of aftercare.

Table 12.1 Microfracture. No specific orthotics necessary

Phase	Range of motion and permitted load	
I	1st to 6th week post-op:	Free mobility Pressure relief
II	from 7th week post-op:	Increase weight load by 20kg/week under medical supervision
II	approx. 3 months post-op:	Start of running training (even ground), cycling, swimming (crawl)
IV	approx. 6 months post-op:	Resumption of sport and sport-specific training (following consultation with a doctor)
	approx. 12 months post-op:	Contact and high-risk sports (depending on size and location of defect – long implant conversion time)

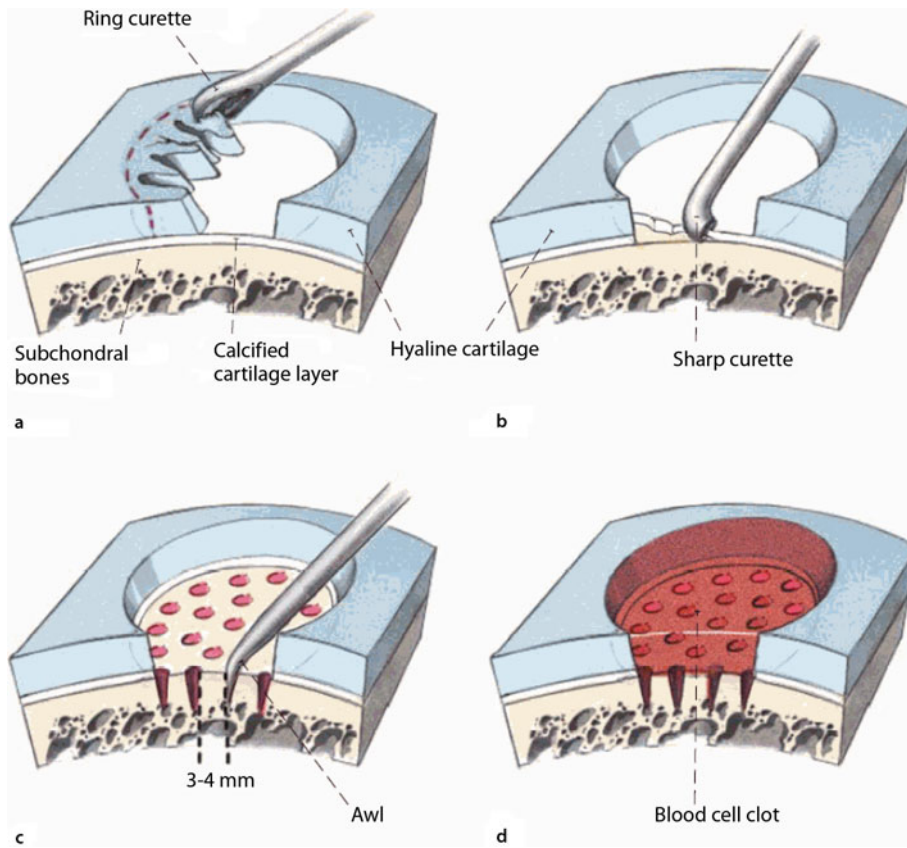


Fig. 12.1 Arthroscopic microfracturing technique. (From Imhoff and Feucht 2013)

12.1.2 Osteochondral Autologous Transfer System (OATS)

Indication

- Osteochondral lesion (<4cm²).
- Focal chondral defects (level II-IV in accordance with Outerbridge) or focally limited osteonecroses.
- Osteochondritis dissecans (level III/IV).

Surgical method

- Primary diagnostic arthroscopy via standard portals to assess the existing pathology.
- Mini-arthrotomy in the area of the defect (access size and location dependent upon defect).
- Punching the defect with one or more extraction cylinders (Fig. 12.2).
- Removing the relevant cylinder dispenser from the area of the lateral trochlea (potentially via an additional small skin incision near the extraction point).
- Inserting the cylinder dispenser into the press-fit technique while monitoring the alignment and position of the cylinder.

Aftercare

Table 12.2 provides an overview of aftercare.

Table 12.2 Osteochondral Autologous Transfer System (OATS). No specific orthotics necessary

Phase	Range of motion and permitted load	
I	1st to 6th week post-op:	Partial load/no weight bearing depending on the location and size of the defect
II	from 7th week post-op:	Increase weight load by 20kg/week Swimming (crawl)
III	approx. 3 months post-op:	Start of running training (even ground), cycling
IV	approx. 6 months post-op:	Resumption of sport and sport-specific training (following consultation with a doctor)
	approx. 9–12 months post-op:	Contact and high-risk sports (depending on size and location of defect)

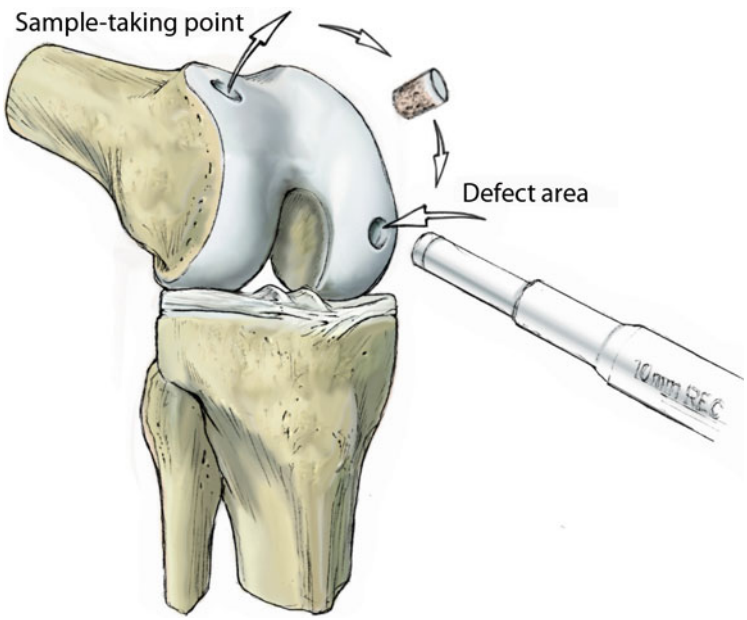


Fig. 12.2 Osteochondral transfer with the single OATS system (Arthrex)

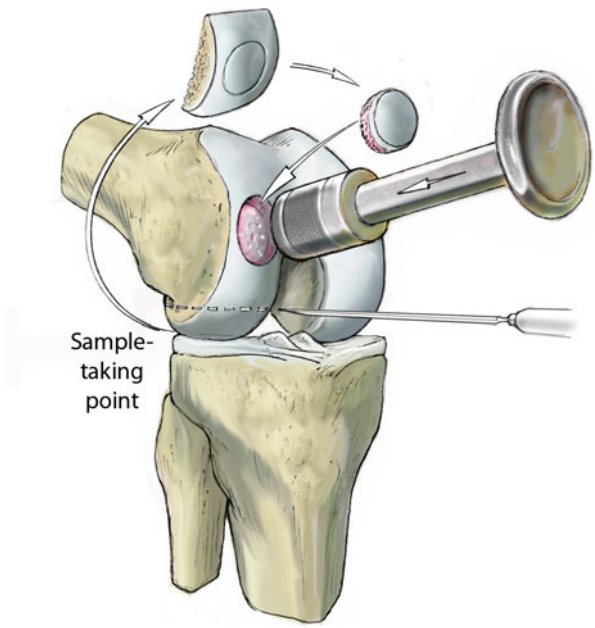
12.1.3 Mega OATS technique

Indication

- In accordance with OATS.
- For defect sizes >4cm^2 up to max. 35mm in diameter.

Surgical method

- Central skin incision with anteromedial or anterolateral capsulotomy.
- Everting the patella laterally or medially (according to the location of the defect).
- Assessment, punching and preparation of the defect.
- Removing the (ipsilateral) posterior condyle by cutting with the knee joint at maximum flexion (◘ Fig. 12.3).



◘ **Fig. 12.3** Osteochondral transplants in mega OATS technique

- Preparing the cylinder acquired in the work station and adapted to the defect.
- Inserting the cylinder in press-fit technique (should stability be insufficient, additional securing through small fragment screws, removal by ASK after six weeks).
- Wound closure layer by layer.

Aftercare

An overview of aftercare can be found in ▶ Table 12.3.

12.1.4 Matrix-associated autologous chondrocyte transplantation (MACT)

Indication

- Focal chondral defects that do not affect the subchondral bone.

Surgical method

Two-sided approach:

- Primary arthroscopy with extraction of the cartilage cells.
- Cultivating cartilage cells in the lab (approx. 3 weeks).
- Second operation using mini-arthrotromy technique (corresponding to the location and extent of the defect).
- Debridement of the cartilage defect and stitching of the molded matrix soaked in cells to the defect using resorbable suture material (◘ Fig. 12.4).
- Wound closure layer by layer.

Aftercare

◘ Table 12.4 provides an overview of aftercare.

◘ **Table 12.3** Mega OATS technique. Four-point hard frame orthotic (medi®-M4-cast) for six weeks post-op (flexion/extension: 90°/0°/0°)

Phase	Range of motion and permitted load	
I	1st to 6th week post-op:	No weight bearing Active flexion/extension: 90°/0°/0°
II	from 7th week post-op:	Free active mobility Increase weight load by 20kg/week under medical supervision
III	approx. 3 months post-op:	Start of running training (even ground), cycling, swimming (crawl)
	approx. 6 months post-op:	Resumption of sport and sport-specific training (following consultation with a doctor)
IV	approx. 9–12 months post-op:	Contact and high-risk sports

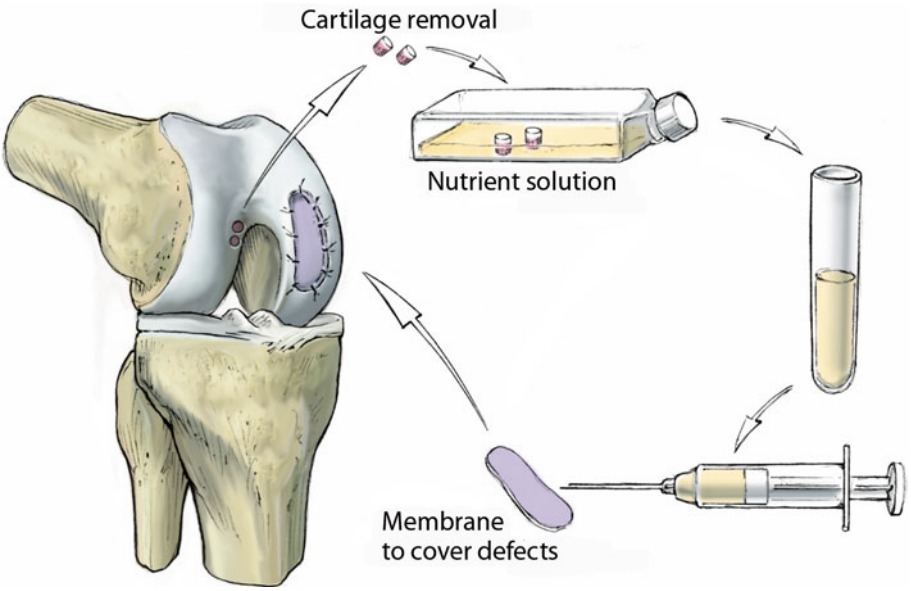


Fig. 12.4 Schematic drawing of the approach in the case of matrix-associated chondrocyte transplants

Table 12.4 Matrix-associated chondrocyte transplant. No specific orthotics necessary

Phase	Range of motion and permitted load	
I	1st to 6th week post-op:	Free mobility No weight bearing
II	from 7th week post-op:	Increase weight load by 20kg/week under medical supervision
II	approx. 3 months post-op:	Start of running training (even ground), cycling, swimming (crawl)
IV	approx. 6 months post-op:	Resumption of sport and sport-specific training (following consultation with a doctor)
	approx. 12 months post-op:	Contact and high-risk sports (depending on size and location of defect – long implant conversion time)

12.1.5 Patella OATS

Indication

- Osteochondral lesions in the region of the posterior surface of the patella (>4cm^2).
- Focal chondral defects (level III/IV according to Outerbridge) and osteonecroses.

Surgical method

- Central skin incision.
- Medial arthrotomy and lateral eversion of the patella (potentially also lateral capsulotomy).
- Drilling defect zones and preparation with the extraction cylinder.
- Removing the cylinder dispenser from the lateral edge of the trochlea (outside of the load zone).
- Inserting the cylinder dispenser into the press-fit technique while monitoring the alignment and position of the cylinder.
- Wound closure layer by layer.

Aftercare

Table 12.5 provides an overview of aftercare.

Table 12.5 Patella OATS. Four-point hard frame orthosis with adjustable stretch position (e.g. medi® M-4-X-Lock hard frame orthosis)

Phase	Range of motion and permitted load	
I	1st to 6th weeks post-op:	Active flexion/extension 90°/0°/0° Partial load with 20kg in extension
II	from 7th week post-op:	Free active mobility Increase weight load by 20kg/week under medical supervision
III	approx. 3 months post-op:	Start of running training (even ground), cycling, swimming (crawl)
IV	approx. 6 months post-op:	Resumption of sport and sport-specific training (following consultation with a doctor)
	approx. 9–12 months post-op:	Contact and high-risk sports

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Cartilage treatment on the knee joint: Rehabilitation

Andreas B. Imhoff, Knut Beitzel, Knut Stamer, Elke Klein

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13.1 Phase I

Phase I of rehabilitation following cartilage surgery corresponds to phase I following hip surgery (▶ Section 7.1).

13.2 Phase II

Goals (in accordance with ICF)

Goals of phase II (in accordance with ICF)

- **Physiological function/bodily structure:**
  - **Promoting resorption**
  - **Regulation of impaired vegetative and neuromuscular functions**
  - **Improving joint mobility**
  - **Avoiding functional and structural damage**
  - Improving joint stability
  - Improvement in functions affecting sensorimotor function
  - Retaining the physiological movement pattern while walking
  - Pain relief
- **Activities/participation:**
  - Exploiting the limits of movement and load
  - Developing dynamic stability when walking, while observing load guidelines
  - Optimization of the support function, core and pelvic stability in movement
  - Independence when meeting the challenges of daily routines
  - Learning a home training program

13.2.1 Physiotherapy

Patient education

- Explanation regarding the necessity of intensive passive movement, e.g., through CPM for 6-8 hours per day within the first six weeks
- **Mega OATS**: Flexion 60°/0°/0° and relaxation for six weeks
- **OATS:** Free mobility and partial load of 10-15kg for six weeks
- **MACI:** Free mobility and relaxation for six weeks
- **Patella OATS:** Partial load only in absolute extension position

Stages of healing in the case of cartilage transplants

Cartilage transplants take over approx. 24 months to heal:

- "Proliferation Stage" (<6 weeks)
- Transition stage (3–4 months)
- "Firmed-up tissue" (3–6 months)
- "Remodeling" (12–24 months)

Prophylaxis

- Active terminal movement in the ankle joints at second intervals.
- Active movement of the upper extremity.
- Everyday activities.
- Controlling the thrombosis pressure pain points upon the onset of pain, increase in swelling and rise in temperature in the relevant areas.

Promoting resorption

- Elevation.
- Active decongestion exercises.
- Manual lymph drainage.
- Smooth suction massage with suction cup along the lymphatic pathways to relieve congestion.
- Isometric tension of the lower extremity.

Improving mobility

Passive movement exercises via CPM should be commenced as early as possible.

Recommendations for the use of the CPM

There exists the following consensus regarding the use of CPM following cartilage treatment:

- CPM from the first day post-op (>12-18 hours post-op)
- For 6-8 hours/day
- For at least 6 weeks post-op
- Alternatively: e.g., ergometer without resistance (60 mins/day)

- Soft tissue treatment:
  - Neighboring muscles: Ischiocrural muscles, psoas muscle, iliac muscle, quadriceps femoris muscle, adductor group, pelvic trochanter muscles, gluteal muscles, quadratus femoris muscle, iliotibial tract, soleus muscle, gastrocnemius muscle, popliteus muscle, long muscles of the foot (**Cave:** Tibialis anterior muscle is detached in the case of high tibial adjustments) through:

INIT
Strain-counterstrain
MET: Five second isometric contraction – relaxation – stretching the muscle. Repeat five times or until no further extension occurs
Cave: At the earliest, do this only at the end of the phase in the case of cartilage surgery, as high static components have an impact on the cartilage!
- Functional massage

In principle, the following is to be noted in the case of cartilage therapy:
- **Avoid holding static loads for a long time and extended periods of compression (as high static components have an impact on the cartilage!)**
- **Following cartilage treatment, only oscillating techniques should be used, as the shearing of pieces of cartilage have the potential to occur**
- **Treatment should take place within the completely pain-free range. Should pain arise, it should be noted that the load limit has already been significantly exceeded, as the cartilage does not have any direct nerve innervation.**

- Active and passive joint mobilization:
  - Passive movement with CPM or bike ergometer
  - Actively assisted movement of the knee joint within the pain-free range, e.g., with the use of skateboards (Fig. 13.1)
  - Independent mobilization through wall slides, simultaneous leg axis training.

The turn-over of the synovial fluid following an operation or immobilization takes approx. 2–3 weeks. During this time, the distribution of pressure on the joint surfaces is not optimum and the protection of the hyaline cartilage is thereby reduced! Due to the diminished load-bearing capacity, shearing movements should be avoided as much as possible.

Regulation of neuromuscular and vegetative functions

- Treatment in the orthosympathetic and parasympathetic areas of origin: Th8–L2 as well as S2–S4: manual therapy, hot rolls, electrotherapy, oscillations.
- Treatment of possible trigger points: TFL, sartorius muscle, quadriceps femoris muscle, adductors, popliteus muscle.
- Vegetative slump: spine flexion + spine lateral flexion + cervical spine lateral flexion and extension.
- Treatment of neurolymphatic and neurovascular reflex points:
  - Gluteus maximus, medius and minimus muscles
  - Ischiocrural muscles
  - Popliteus muscle
  - Rectus femoris muscle
  - Sartorius muscle
  - Tensor fasciae latae (TFL)
  - Tibialis anterior and posterior muscles.

Improving sensorimotor function

- Electrical muscle stimulation: visible muscle contraction.
- PNF above the upper extremity, contralateral side (overflow) and the core in gait pattern

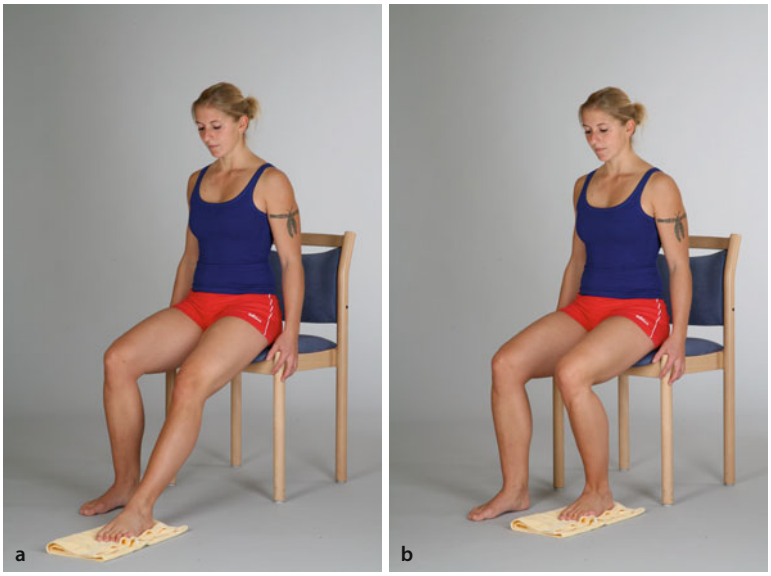

Fig. 13.1a,b Actively assisted movement of the knee joint within the pain-free range

Fig. 13.2 Closed system exercise on unstable support surfaces: starting in seated position in conjunction with unstable aids (balance board)

Fig. 13.3 Awareness training for the knee joint and the entire leg axis as well as posture

- Closed system exercises on unstable surfaces: e.g., starting in sitting or half-sitting position in conjunction with upper extremity and/or unstable aids, e.g., balloon, balance board (Fig. 13.2).
- Coordination training under relaxation or partial load.
- Isometry.
- Increasing closed chain sensomotoric exercises.
- Awareness training for the knee joint and the entire leg axis as well as posture (Fig. 13.3).

Stabilization and strengthening

- Isometry from various angle positions.
- Strengthening the supporting muscles of the arms.
- Awareness of three-point foot weight-bearing as a basis for the leg axis, with static core involvement. The pressure-bearing points of the foot are supported on wooden blocks. The patient should firstly perceive the pressure points and then build up the arch of the foot.
- Leg axis training: Using a mirror, the patient can visualize his/her new leg axis and initially receives additional tactile support from the therapist:
- Stabilization in typical walking positions – overflow from the PNF concept:
  - For supporting leg activity on the side that underwent surgery:
    Starting in lateral/supine position: leg pattern flexion adduction ER contralaterally
    Starting in lateral/supine position: foot pattern plantar flexion pronation ipsilaterally
    Starting in lateral position with side that underwent surgery open: pelvic pattern in anterior elevation
  - For swing leg activity on the side that underwent surgery:
    Starting in lateral/supine position: leg pattern extension abduction IR contralaterally
    Starting in supine /lateral position: foot pattern in DE inversion for further tension in flexion-adduction-ER or DE eversion for flexion-abduction-IR (symmetrically or reciprocally) ipsilaterally
    Starting in supine/lateral position/seated: ipsilateral arm pattern in extension-abduction-IR.
- Strengthening the pelvic and leg muscles from lateral position, prone position, supine position: PNF extended and bent pattern with resistance from different positions (but not distally). **Cave:** No rotation in knee joint! (Fig. 13.4)
- Oblique vastus medius muscle training (perception, tactile stimuli), e.g., dorsal extension + supination
- Dynamic training of core control or core and foot stability.
- Exercise pool: stabilization and mobilization exercises.

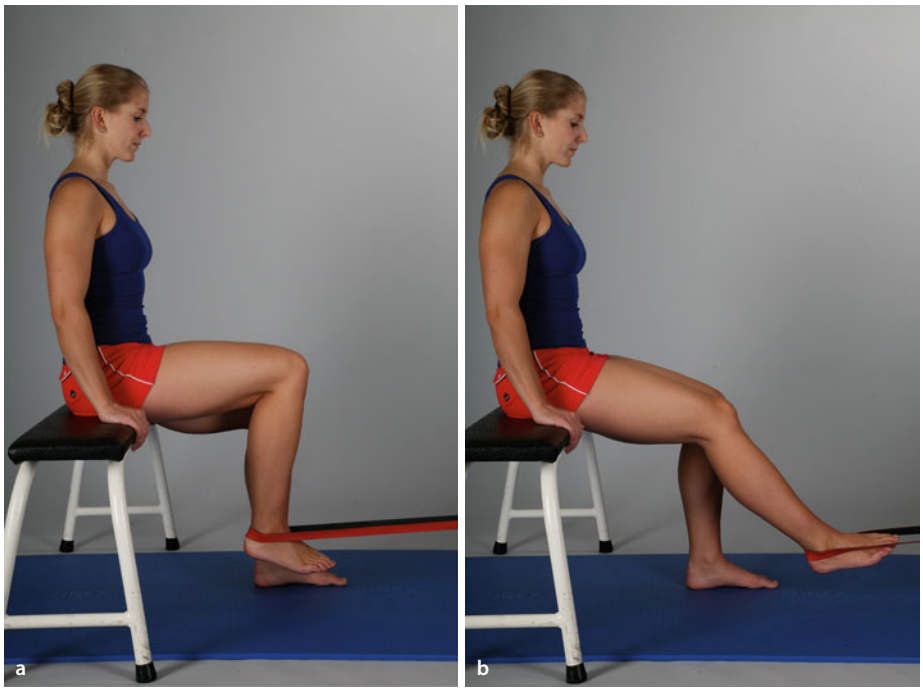

Fig. 13.4a,b Strengthening the pelvic and leg muscles

Gait

- Ascend step with step-to-step technique: healthy leg in front when ascending (Fig. 13.5a), injured leg in front when descending.
- Learning four-point or three-point gait – depending on load guidelines and while observing leg axis and posture.
- Training the rolling phase.
- Controlling stair climbing with step-to-step technique (Fig. 13.5b).
- Load control on the force measurement plate.
- Posture control.
- Everyday activities: training getting into and out of the therapy car.
- Therapy garden: walking on different surfaces, slanted planes, inclines.

Physical measures

- Manual lymph drainage.
- Compression bandage.
- CTM: arterial leg zone, venous lymphatic vessel area, extremity.
- Pneumatic pulsation therapy: regulation and relaxation of muscle tone:
  - Loosening of tissue compressions
  - Activation and increase of lymph flow
  - Stimulating blood circulation, including in deep areas of tissue.
- Cryocuff – mild cooling and electrotherapy to promote local resorption, e.g., diadynamic currents.
- Acupuncture massage:
  - Ventral: stomach-spleen-pancreas-meridian
  - Lateral: gall bladder meridian
  - Dorsal: bladder meridian
  - Medial: kidney and liver meridian.
- TENS.
- Electrostimulation: at least 1.5 hours per day.
- Hot rolls on the sole of the foot to stimulate foot reflexology.
- Cryokinetics: intermittent brief application of ice pack (cooling for 20 seconds, then activating the extremity until the skin is warm again, then repeat the cooling; 3-4 intervals).
- CPM movement cast: six hours per day with repeated applications.

13.2.2 Medical training therapy

- General accompanying training of the core and the upper extremity: pilates, lateral pull, dip trainer, rowing, bench press, abdominal and back training.

Endurance training

- Three-point ergometer without the use of the extremity concerned insofar as load-bearing is not permit-

Fig. 13.5a,b Ascend step with step-to-step technique: **a** Healthy leg in front when ascending, **b** Controlling stair climbing with step-to-step technique

ted. Potentially with shortened crank for TB.
- Ergometer training: 1 × 10 up to 2 × 15 mins with low load at 20–50W, potentially shortened crank.
- Gait training.

Strength training

- Intramuscular activation via isometry.
- Strength endurance training, adjusted to plans; focus on local stabilizers: 4 × 20 (–50) repetitions within the completely pain-free range.
- Overflow via the contralateral side (strength endurance training;4 × 20 reps) starting in supine position: cable pulley exercises in PNF diagonal patterns.
- Training hip joint stabilizers:
  - Flexion/extension (in supine position, heels flat on the floor with hips in flexion; leg lifts in prone position on the bench)
  - Abduction/adduction (standing with lateral fixation, foot on a tile, slide sideways)
- Slides on slideboard or Flowin mat (Fig. 13.6).
- Extension (stretching via supported position from 20° flexion into full extension, without load). **Cave:** Pay attention to retropatellar symptoms, not in the case of retropatellar cartilage reconstruction
- Training ankle joint stabilizers:
  - Plantar flexion in seated starting position: Vitality band around the forefoot, attach with the hands, slow plantar flexion and eccentric slackening until in neutral position.
  - Dorsal extension in seated starting position: Vitality band attached from in front (e.g., on wall bars or table leg), lower leg slightly supported, then dorsal extension against traction from the Thera-Band
  - Calf muscle training (Fig. 13.7).

Fig. 13.6 Slides on the Flowin mat

Fig. 13.7 Training the calf muscles under pressure relief

Criteria for strain restrictions
- 24 hour pain behavior
- Swelling/effusion
- Redness
- Overheating
- Reduction or stagnation of range of motion
- Reduction or stagnation of strength

13.3 Phase III

Goals (in accordance with ICF)

Goals of phase III (in accordance with ICF)
- **Physiological function/bodily structure:**
  - **Improving joint mobility**
  - **Optimization of core and pelvic stability**
  - **Restoration of muscular strength**
  - **Restoration of dynamic joint stability**
  - Optimization of functions affecting sensorimotor function
  - Optimization of a coordinated movement pattern along the kinematic chain during movement
  - Optimization of the gliding ability of neural structures
- **Activities/participation:**
  - Developing ergonomic posture and movements in everyday routine, at work, during sport
  - Resumption of professional activities
  - Active participation in the life of the community/family life

13.3.1 Physiotherapy

Patient education
- Discussing the content and goals of treatment with the patient.
- Information regarding return to work and to sport.
- Informing the patient about the restrictions they will still have:
  - **Cartilage surgery:** From approx. 3 months post-op, beginning with running training
- Ergonomic advice for everyday life, work and sport.

Following chondrocyte transplantation, a long rehabilitation time is required until the regenerate has fully matured (approx. 18-24 months). The greatest transplant sensitivity is experienced within the first three months following the implant. In this period, impact and shear loads on the transplant area should be avoided.

Improving mobility
- Mobilization of the patella; with/without compression, static and with movement.
- Active and passive joint mobilization:
  - Actively-assisted movement of the knee joint within the pain-free range
  - Independent mobilization with simultaneous leg axis training, e.g., via wall slides
  - Mobilization of the patella (4 directions)
  - Mobilization under compression.
- Mobilization of the neighboring joints: pelvis, lumbar spine, distal and proximal tibiofibular joint depending on findings.
- Mobilization of neural structures:
  - Straight leg raise (SLR)
  - Prone knee bend (PKB) for saphenous nerve (knee joint extension + hip extension/abduction/ER + foot EV/DE or plantar flexion)
  - Slump.
- Manual therapy.
- Soft tissue treatment:
  - Neighboring muscles: ischiocrural muscles, psoas muscle, iliac muscle, iliotibial tract, adductor

group, pelvic trochanter muscles, gluteal muscles, quadratus femoris muscle, soleus muscle, gastrocnemius muscle, popliteus muscle, long muscles of the foot through:
INIT
Strain-counterstrain
MET: Five second isometric contraction – relaxation – stretching the muscle. Repeat five times or until no further extension occurs
Relaxation techniques from the PNF concept (hold relax and contract relax for antagonist inhibition, rhythmic stabilization)
Functional massage
  - Treating ligament structures through cross-fiber massage on: meniscofemoral and meniscotibial ligaments, suprapatellar recess, collateral lateral ligament, patellar ligament
  - Fascia treatment through pressure and release techniques on the pelvis and the lower extremity, e.g., long plantar ligament, fascia cruris, lateral thigh fasciae, ischiatic fascia on the thigh and lower leg, fascia lata, plantar fascia
  - Treatment of myofascial structures: superficial back and front lines, spiral line and lateral line.
- Active and passive joint mobilization:
  - Active movement of the knee joint within the pain-free range from various starting positions
  - Independent mobilization and leg axis training via wall slides
  - Treatment of patella problems
  - Improvement in the timing of the vastus medialis oblique muscle (VMO should be activated earlier and more strongly than the VLO along the entire path of movement in eccentric and also concentric exercise)
  - Subsequent integration into the overall muscle synergies (supinators, adductors, gluteal muscles)
  - Leg axis training in order to better control the dynamic Q angle (less valgus, less medial rotation of the lower leg)
  - Stretching or extension to tight support structures (retinacula, iliotibial tract, VLO, patella tendon).
- Activation of the quadriceps femoris muscle: promoting sliding between the surface and deep layer of the suprapatellar recess to prevent adhesions.
- Improving tissue displacement in the surgical area.
- Checking the cause-effect chain (see ▶ Section 7.3.1).
- Automobilization for extension and flexion: e.g., starting in standing position: Foot is rested on a chair or stool. By shifting weight forwards, a shift in pivot takes place, which expands the knee flexion.

Fig. 13.8 Mobilization of neural structures

- Alternatively: shifting weight from quadrupedal position with buttocks in zen pose without swaying the pelvis
- Mobilization of neural structures with techniques: PKB, SLR or Slump (Fig. 13.8).

Regulation of vegetative and neuromuscular functions

- Treatment of tender points:
  - Strain-counterstrain technique: Apply pressure to the point of pain or to the most hardened area of the muscle. Relaxing the tissue by moving the neighboring joints until the pain subsides or the tissue has noticeably relaxed. Hold this position for 90 seconds and then passively(!) return to the starting position.
- Treatment of trigger points:
  - INIT: Apply ischemic compression to the trigger point through pressure, until the pain lessens. Should no change in the pain occur after 30 seconds, relieve compression and apply a positional release technique, i.e. convergence of structures until release. Then seven seconds of isometric tensing and stretching of the muscle.

Improving sensorimotor function

- Coordination-promoting exercise on various unstable support surfaces:

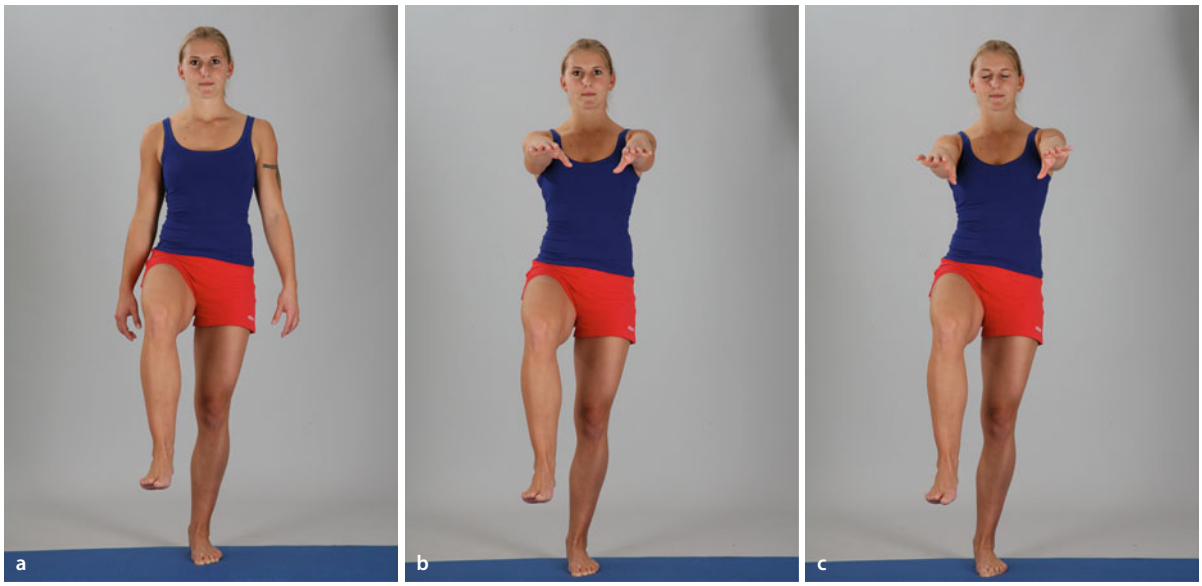

Fig. 13.9a–c Exercises that promote coordination, more advanced option with closed eyes or with additional tasks

- Stabilization exercises on one or both legs with obstruction: seesaw board, Gymstick, balance board, stabilization pad, platform (Fig. 13.10).
- Perception of balanced standing position while standing bipedally (calcaneus bone and metatarsal bones touching), with eyes closed.
- Biofeedback, e.g., via surface EMG.
- Closed system exercises, including on unstable surface with additional tasks (Fig. 13.9, Fig. 13.11).
  Order:
  - Eyes open
  - Looking away
  - Eyes closed.

Stabilization and strengthening

- Wall slides (eccentric stabilization).
- Intensive strengthening of the foot and lower leg muscles, e.g. Nurejew soleus muscle gastrocnemius muscle.
- Step-ups initially under partial load, then increasingly raise the load until full load with additional weight: cranial ventral shift in body weight while monitoring body stability.
- Dynamic one-leg stabilization: lunge with leg that underwent surgery forwards; shifting center of gravity caudally and cranially while controlling stability. Maximum knee flexion 60°!
- Stabilization with traction device (leg that underwent surgery on balance board, seesaw board, foam material), on one or both legs.

Fig. 13.10a–c Stabilization exercises on one or both legs with obstruction under as low a load on the patellofemoral joint as possible

Fig. 13.11 Closed system exercises with additional tasks

Focus of rehabilitation following cartilage treatment

- Protecting the transplant
- Restoration of range of motion (FROM)
- Developing muscular control and sensorimotor function
- Progressive increase in weight load

Gait

- Leg axis training:
  - Develop three-point weight-bearing on the foot
  - Positioning the knee joint to prevent medial collapse
  - Correction of the hip joint in front, sagittal and transverse level
  - Neutral position of the lumbar spine.
- Potentially weaning off crutches.
- Increasing the simulation of everyday strains (e.g., walking in the walking garden with additional tasks) with different coordination options (backwards, sideways, slowly, quickly etc.) on different ground surfaces.
- Use of visual (mirror, floor markings) and acoustic (rhythmic tapping) aids.
- Intensification of training to improve perception, adapted to potential new strains, e.g., walking on different surfaces with visual and acoustic distractions: walking on the garden paths/walking course while simultaneously
  - Holding a conversation
  - Opening an umbrella
  - Singing a song
  - Coordinative variations (backwards, sideways, slowly, quickly)
  - Differing illumination (simulation of everyday situations).
- Increasing the exercise duration on the treadmill while checking in mirror.
- Video gait analysis as feedback for the patient.
- Walking on the force measurement plate for load control: Is load borne on the side that was operated on?
- Under full load, walking (1-6km/hour) or brisk walking (6-8km/hour) – no jogging.
- Walking against resistance, Vitality band, cable pulley, e.g., life line.
- Monitoring lower leg acceleration in the terminal swing phase.

Physical measures

- Lymph drainage.
- Regeneration massage for overstrained muscle sections.
- Electrotherapy: iontophoresis, diadynamic currents, high voltage.
- Acupuncture massage: energetic treatment of the scar.

Criteria for strain restrictions

- 24 hour pain behavior
- Swelling/effusion
- Redness
- Overheating
- Reduction or stagnation of range of motion
- Reduction or stagnation of strength

13.3.2 Medical training therapy

- General accompanying training of the core and the upper extremity: rowing, lateral pull, bench press, dip trainer, abdominal muscle training.
- Weaning off crutches through gait training.

Sensorimotor function training

- Developing the stabilization of the leg axis under variable conditions, including with medium loads, e.g., standing stabilization on instable surface with lateral cable pulley load, mat.
- Single-leg standing exercises under variable conditions:

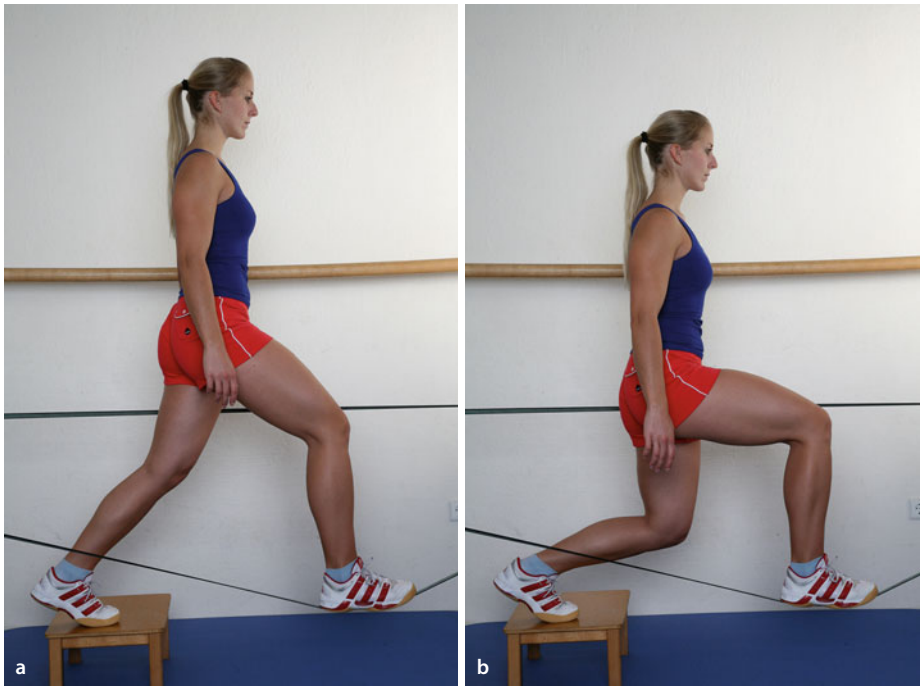

Fig. 13.12a,b Bearing weight on one leg, different flexion angles: Stabilization of core, leg axis, foot arch

- Bearing weight on one leg, different flexion angles: stabilization of core, leg axis, foot arch: standing on Dotte swing, rotation plate, Haramed, balance board + Vitality band (Fig. 13.12)
- Developing foot stabilization and dynamic: e.g., spiral dynamic screw connection of the foot, load distribution training of the foot in dynamic situations, e.g., stabilize on one leg in side step while complying with three-point load
- Squats within permitted range of motion on both leg or on one leg with a smaller range of motion while checking using a mirror. Preventing a medial collapse when bearing a weight.

- Developing walking alphabet.
- Training in Redcord system: leg axis training.
- Feedback training, also with medium loads: e.g., single-leg squats on proprio-swing system.
- Sport-specific conditioning: e.g., sidestep tennis, skating, pass basketball, ice hockey passing (Fig. 13.13).

Strength training

- Endurance strength training, as warmup exercise for the local stabilizers, see ▶ Section 13.2.2.
- Hypertrophy for general musculature, medium range of motion: 6 × 15 reps, 18/15/12/12/ 15/18; as pyramid, (**Cave:** Within the completely pain-free range!).
- Knee-bends: leg presses, reformers, shuttle, squats and variants: Hack squats, front squats, squat lunges.

Fig. 13.13 Sport-specific conditioning of the movement patterns in: ice hockey passing

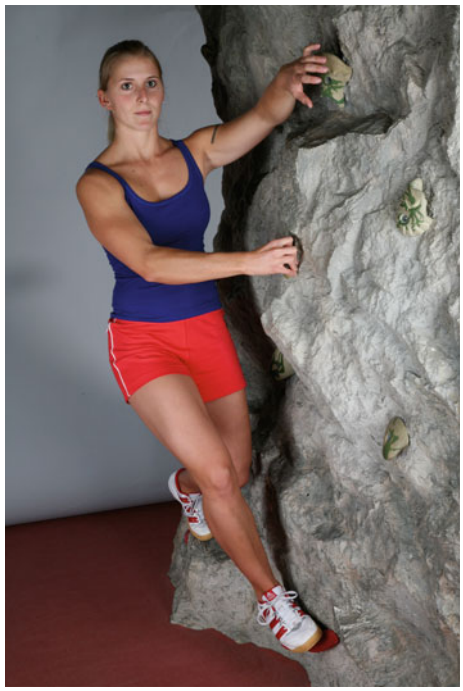

Fig. 13.14 Step alternating training in positive wall area

- Hamstring curls.
- Calf training.
- Ab/adductor training.
- Training the core and gluteal musculature (good morning, rowing bend over, barbell rowing).

Endurance training:

- Ergometer training 20–30 mins with increasing duration and wattage depending on physical condition.
- Treadmill exercise: walking uphill 10–20 mins 10% incline at 3–5km/h.

Therapeutic climbing

- Initial stabilization from deep joint position in vertical wall area with traction support: frontal standing, hands grabbing above shoulder height, raising out of deep angle position by stepping, with arms supporting the movement.
- Approval of rotational starting pattern (as above, but from slightly wound position).
- Step alternating training in positive wall area (arms hold two handles in place, legs alternate on different steps, determination of certain movement consequences (moves) (up/down, side to side) (Fig. 13.14).

13.4 Phase IV

The objective of training in phase IV lies in the patient's ability to resume sporting activities. The sports-therapeutic content of rehabilitation phase IV following cartilage treatment is summarized for the entire lower extremity in ▶ Section 15.4.

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Ankle joint: Surgical procedure/aftercare

Andreas Imhoff, Knut Beitzel, Knut Stamer, Elke Klein

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14.1 Tendon repair

14.1.1 Percutaneous frame suture of the Achilles tendon

Indication

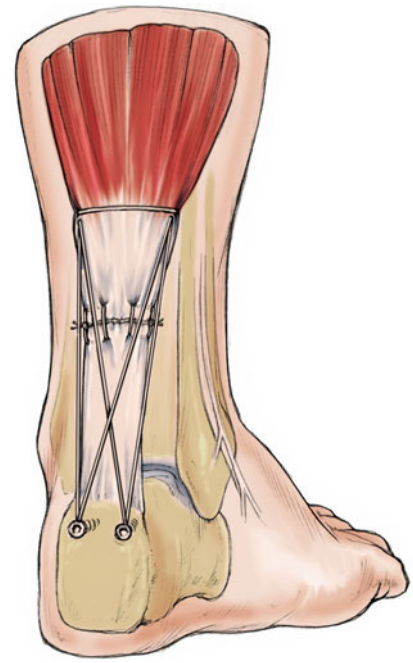
- Acute rupture (insufficient convergence of the tendon stumps in plantar flexion [> 5mm]).
- Chronic rupture or re-rupture (failure of conservative measures, tendon plastic surgery may be required).

Surgical method

- Approx. 3cm long skin incision (at rupture level), potential hematoma drainage.
- Debridement of the ends of the rupture and removing necrotic tissue.
- Approx. 1-2cm long incision on each side (laterally/medially), approx. 3cm proximal to the rupture height and distally near the tendon insertion.
- Guiding through two threads (e.g. Fibrewire) and insertion of an X-shaped framework suture ◘ Fig. 14.1).
- Monitoring re-adaptation and tendon tension.
- Wound closure layer by layer.

Aftercare

◘ Table 14.1 provides an overview of aftercare.



◘ **Fig. 14.1** Frame suture of the Achilles tendon

◘ **Fig. 14.1** Percutaneous frame suture of the Achilles tendon. 1st to 2nd week post-op: Stapedial cast, 3rd to 6th weeks post-op: Aircast walker/walking cast with wedge, from 7th week post-op: Achilloprotect cast for up to six months post-op (**Cave:** Also while showering!)

Phase	Range of motion and permitted load	
I	1st to 2nd weeks post-op:	Active assisted Plantar flexion/dorsal extension free/30°/0° Pressure relief in stapedial cast
II	3rd to 4th weeks post-op:	Increase in pain adapted to the level of pain in aircast walker (with wedge plantar flexed 15°) Active assisted Plantar flexion/dorsal extension free/15°/0°
	5th to 6th weeks post-op:	Depending on pain, full weight in aircast walker (without wedge) Active assisted plantar flexion/dorsal extension free/0°/0°
III	from 7th week:	Approving dorsal extension (only following medical consultation)
IV	approx. 3 months post-op:	Swimming (crawl)
	approx. 4 months post-op:	Start of running training (even ground), cycling
	approx. 6 months post-op:	Resumption of sport and sport-specific training (following consultation with a doctor)
	approx. 9–12 months post-op:	Contact and high-risk sports (following consultation with a doctor)

14.2 Capsule/ligament reconstructions

14.2.1 Upper ankle joint ligament surgery (lateral)

Indication

- Chronic lateral instability.
- Two-stage rupture in the case of existing instability of the lateral capsule/ligament apparatus.
- Relative indication in at least second degree ligament rupture in a highly active athlete (at least rupture of anterior talofibular ligament and calcaneofibular ligament).

Surgical method

- Approx. 4cm long curved skin incision around the distal head of the fibula.
- Approx. 2cm long second skin incision in the area of the metatarsal basis V.
- Preparation of the distal fibular and the lateral ligamentous apparatus (assessing the ligament stump and remaining tissue).
- Preparation and mobilization of the tendons of the peroneus brevis muscle as well as the distal detachment of the halves of the tendon (splitting of the tendon).
- If necessary use of an alternative autologous tendon transplant (e.g., gracilis)
- Removal of the split tendon using a tendon stripper while protecting the peroneal tendon compartment.
- Preparation and insertion of a drill channel at the anatomical insertion site of the anterior talofibular ligament.
- Preparation and drilling of two sagittal fibular channels (area of origin of the anterior talofibular ligament and calcaneofibular ligament).
- Preparation and insertion of a drill channel in the area of the anatomical insertion of the calcaneofibular ligament.
- Fixation of the tendon transplant with bioresorbable screws in the talus bone, drawing the transplant through the fibular drill channels and calcaneal fixation in pronation with a bioresorbable screw under tension controlling (◘ Fig. 14.2).
- Wound closure layer by layer.

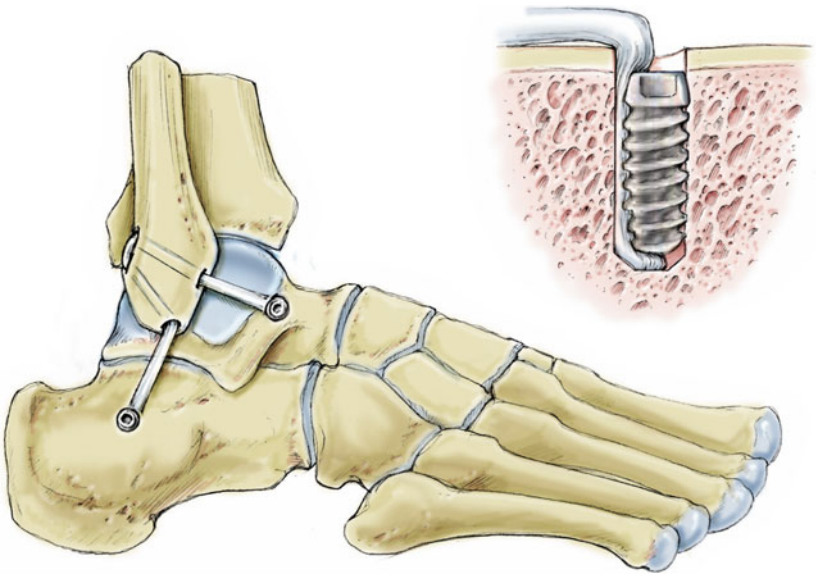
Aftercare

◘ Table 14.2 provides an overview of aftercare.

14.2.2 Upper ankle joint syndesmosis reconstruction (Tight Rope®)

Indication

- Acute syndesmosis rupture (potentially in addition to osteosynthesis in the case of Weber B and C fractures).
- Chronic and previous syndesmosis rupture (chronic instability).



◘ **Fig. 14.2** Lateral tendon augmentation of the upper ankle joint

Table 14.2 Upper ankle joint ligament surgery (laterally). 1st to 2nd weeks post-op: Lower leg cast in plantar flexion/dorsal extension: 0°/0°/0°, 3rd to 6th weeks post-op: aircast walker/walking cast

Phase	Range of motion and permitted load	
I	1st to 2nd weeks post-op:	Pressure relief in plaster cast No pronation or supination Free active dorsal extension/plantar flexion out of the cast
II	3rd to 6th weeks post-op:	Full weight in aircast walker/walking cast No pronation or supination Free active dorsal extension/plantar flexion out of the cast
III	from 7th week post-op:	Free range of movement
IV	approx. 3 months post-op:	Swimming (crawl), start of running training (even ground), cycling
	approx. 6 months post-op:	Resumption of sport and sport-specific training, contact and high-risk sports (following consultation with a doctor)

Surgical method

- Approx. 2cm long incision approx. 3cm proximally to the lateral malleolus (or via an existing access under simultaneous osteosynthesis).
- Inserting a drill hole between the fibula and tibia.
- Pulling a thread medially through the skin with a needle.
- Drawing in the Tight Rope® (Arthrex) via the passage sutures, tilting and medial splinting of the metal plate.
- Tension control and tying the Tight Rope from lateral direction (Fig. 14.3).
- Wound closure layer by layer.

Aftercare

Table 14.3 provides an overview of aftercare.

Table 14.3 Ankle syndesmosis reconstruction (Tight Rope®, Arthrex)

Table 14.3 Ankle syndesmosis reconstruction (Tight Rope®). 1st to 2nd weeks post-op: lower leg cast in plantar flexion/dorsal extension: 0°/0°/0°, 3rd to 6th weeks post-op: Aircast walker/walking cast

Phase	Range of motion and permitted load	
I	1st to 2nd weeks post-op:	Pressure relief in the plaster cast No pronation or supination Dorsal extension/plantar flexion out of the cast: 20°/0°/0°
II	3rd to 6th weeks post-op:	Full weight in aircast walker/walking cast No pronation or supination Dorsal extension/plantar flexion out of the cast: 20°/0°/0°
III	from 7th week:	Free mobility and full load
IV	approx. 3 months post-op:	Swimming (crawl), start of running training (even ground), cycling
	approx. 6 months post-op:	Resumption of sport and sport-specific training, contact and high-risk sports (following consultation with a doctor)

14.3 Cartilage surgery

14.3.1 Talus OATS

Indication

- Limited osteochondral lesion.
- Focal chondral defects (level III-IV in accordance with Outerbridge [>50% of the cartilage density]) or focally limited osteonecroses.
- Osteochondritis dissecans (level III/IV).

Surgical method

- Approx. 4cm long medial or lateral skin incision ventrally to the correspond malleolar.
- Preparation, arthrotomy with depiction of the chondral defect (medially: potentially medial malleolar osteotomies, laterally: bony deepening of the syndesmosis required for depiction).
- Punching the chondral defect with the extraction cylinder (usually 1-2 cylinders).
- If necessary, removal of an autologous cylinder dispenser from the ipsilateral trochlea of the knee joint via a lateral mini-arthrotomy.
- Insertion of the cylinder dispenser (manufactured cylinder dispenser such as Bio Matrix or autologous cylinder) into the talar defect zone with the press-fit technique while controlling position (Fig. 14.4).
- Wound closure layer by layer.

Aftercare

Table 14.4 provides an overview of aftercare.

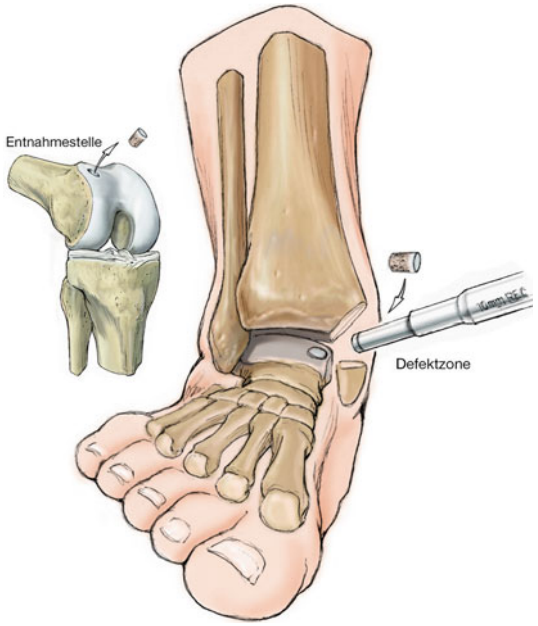


Fig. 14.4 Autologous bone-cartilage transplant and medial malleolar osteotomies with the cylinder dispenser removed from the proximolateral femur condylus

Table 14.4 Talus OATS. 1st to 6th week post-op: lower leg cast in plantar flexion/dorsal extension: 0°/0°/0°

Phase	Range of motion and permitted load	
I	1st to 6th week post-op:	Pressure relief No pronation or supination Dorsal extension/plantar flexion out of the cast permitted (free mobility in knee joint)
II	from 7th week post-op:	Inspecting plaster cast Increase load slowly under X-ray monitoring (20kg/week) Free range of movement Swimming (crawl)
III	approx. 3 months post-op:	Start of running training (even ground), cycling
IV	approx. 6 months post-op:	Resumption of sport and sport-specific training, contact and high-risk sports (following consultation with a doctor)

Table 14.5 Upper ankle joint total endoprosthesis (Salto®). Lower leg cast in plantar flexion/dorsal extension: 0°/0°/0° for 6 weeks post-op

Phase	Range of motion and permitted load	
I II	1st to 6th week post-op:	Pressure relief No pronation or supination Dorsal extension/plantar flexion out of the cast permitted
III	from 7th week post-op:	Free range of movement and increase in load by 10kg/week (following clinical and radiological inspection), swimming
IV	approx. 4 months post-op:	Cycling A further increase in load requires a specific therapy decision/contact and high-risk sports not recommended

14.4 Endoprosthesis

14.4.1 Upper ankle joint total endoprosthesis (Salto®)

Indication

- Primary and secondary arthroses of the upper ankle joint (ligamentous apparatus stable).
- Rheumatoid arthritis.

Surgical method

- Generous anterior access and potential osteophyte removal.
- Alignment of the saw guide and resection of the tibial section as well as the talar dome.
- Further preparation of the talus and the distal tibia under constant axial and position control.
- Determination of the implant size and soft tissue balancing through trial implant.
- Insertion of the tibial and talar implant as well as mobile inlay.
- Potentially additional percutaneous Achilles tendon scarring.
- Wound closure layer by layer.

Aftercare

Table 14.5 provides an overview of after-care.

14.5 Arthrolysis

14.5.1 Upper ankle joint arthrolysis

Indication

- Clinically significant movement restrictions of the upper ankle joint.
- Soft-tissue or osseous impingement (e.g., post-traumatic, post-op, post-infectious).

Surgical method

Arthroscopic:

- Access via anterior standard portals and potentially additional dorsal portals.

Open surgery (rarely necessary):

- Skin incision and mini-arthrotomy corresponding to the underlying pathology.
- Removing any osteophytes and potential removal of free joint bodies, resection of scarring and adhesions while controlling the range of motion.
- Wound closure layer by layer.

Aftercare

Table 14.6 provides an overview of aftercare.

Table 14.6 Upper ankle joint arthrolysis. No specific orthosis therapy required

Phase	Range of motion and permitted load	
I II	1st to 2nd week post-op:	Partial load with 20kg
III IV	from 3rd week post-op:	Increasing load up to full load (depending on pain and effusion), released as able to resume sporting activities

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Ankle joint: Rehabilitation

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15.1 Phase I

Phase I of rehabilitation following cartilage surgery corresponds to phase I following hip surgery (▶ Section 7.1).

15.2 Phase II

Goals (in accordance with ICF)

Goals of phase II (in accordance with ICF)

- **Physiological function/bodily structure:**
  - **Promoting resorption**
  - **Pain relief**
  - **Avoiding functional and structural damage**
  - **Regulation of impaired vegetative and neuromuscular functions**
  - Retaining joint mobility
  - Improvement in functions affecting sensorimotor function
  - Retaining the physiological movement pattern while walking
- **Activities/participation:**
  - Developing dynamic stability when walking, while observing load guidelines
  - Optimization of the supporting role of core and pelvic stability in movement
  - Independence when meeting the challenges of daily routines
  - Exploiting the limits of movement and load
  - Learning a home training program

15.2.1 Physiotherapy

Patient education

- Discussing the content and goals of treatment together.
- Explaining what is necessary and forbidden in the case of **tendon reconstructions:**
  - Dorsal extension above the neutral position only from the 7th week post-op
  - Load from 3rd week post-op only with Aircast Walker:
    - Controlling gait load
    - Explaining the situation to the patient to reduce fear of movement and to promote the permitted movement: information regarding the patient's personal pathology (using a foot model or illustrations), the status of wound healing and the associated resilience and mobility.
  - Explaining about restrictions for capsule/ligament reconstruction:
    - No pronation or supination permitted
    - Starting crawl swimming approx. three months post-op.
- Handling the orthosis.
- Information regarding limitations of **cartilage treatment:**
  - No load
  - No pronation or supination for 6 weeks post-op
  - Avoid standing for too long: Increased swelling can lead to wound healing problems.
- Information regarding recommendations for **endoprosthetics**:
  - No jumping
  - In general, avoid high-risk sports
  - Start with swimming, stationary bicycle from approx. 7th week post-op
  - From approx. 4 months post-op: cycling.
- **Arthrolysis:** explanation of the necessity for intensive mobilization techniques and the active cooperation of the patient.

Prophylaxis

- Isometric training of the leg muscles.
- Active movement of the upper extremity.
- Inspecting the thrombosis – pain pressure points upon onset of pain and increase in swelling in corresponding areas.
- Everyday activities.
- Getting up and walking around frequently: more often but for shorter periods due to the risk of increased swelling.
- Thrombosis and pneumonia prevention depending on the condition of the patient.

Promoting resorption

- Elevation.
- Active decongestion exercises.
- Learning independent exercise programs in the case of **arthrolysis:**
  - Flexion: Zen pose
  - Extension: stepping forward, move knee joint in extension forward from DII (shifting weight), heel remains on the floor, bend knee joint or shift forwards medially or laterally on bar, heel remains on the floor (◘ Fig. 15.1).
- Manual lymph drainage.
- Cryocuff.
- Compression bandage.
- Leg water treatment, knee water treatment.

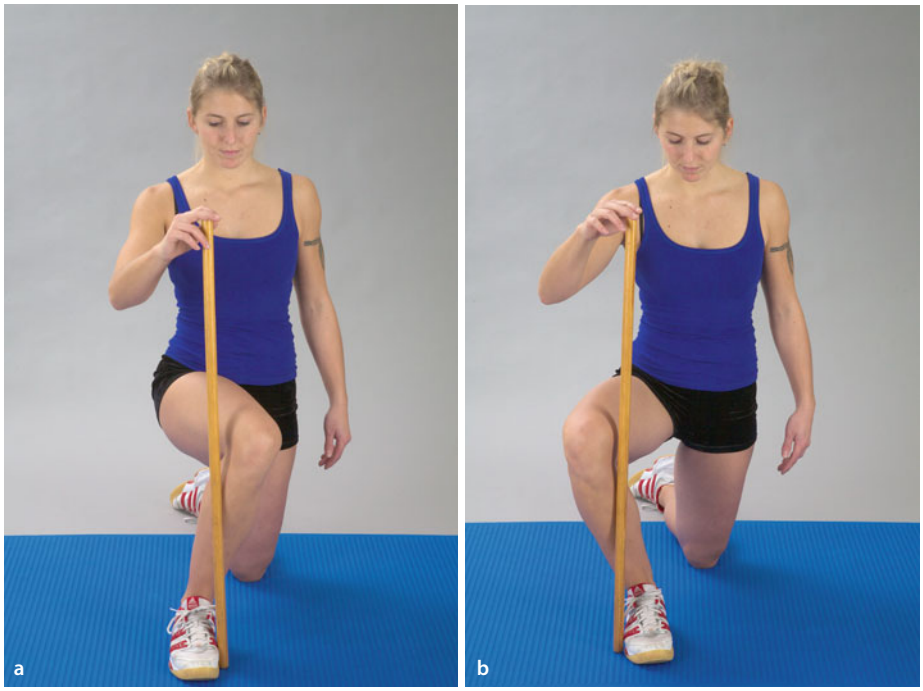


Fig. 15.1a,b Independent exercise program in the case of arthrolysis: extension: sepping forward, move knee joint in extension forward from DII (shifting weight), heel remains on the floor, shift knee joint forwards **a** Medially or **b** Laterally on bar, heel remains on the floor

Improving mobility

- Soft tissue treatment:
  - Treatment of the surrounding muscles: gastrocnemius muscle, soleus muscle, long foot muscles, peroneal muscles, tibialis anterior muscle through integrated neuromuscular inhibition technique (INIT), strain counterstrain (SCS), post-isometric relaxation (PIR), contract-relax, muscle energy technique
  - Fasciae techniques (pressure and release techniques) on the pelvis and lower extremity: e.g., long plantar ligament (Fig. 15.2a), crural fascia, lateral thigh fasciae, sciatic fasciae of thigh and lower leg (Fig. 15.2b), fasciae latae.
- Screw connection of rearfoot over forefoot (Fig. 15.3).
- Pain-free and relaxed mobilization of the upper ankle joint in all free directions, with and without compression. **Cave***:* For cartilage/ligament reconstruction.
- **Cartilage treatment:** careful mobilization of the upper ankle joint within free range of motion (not terminal, as there is a risk of cartilage destruction in that

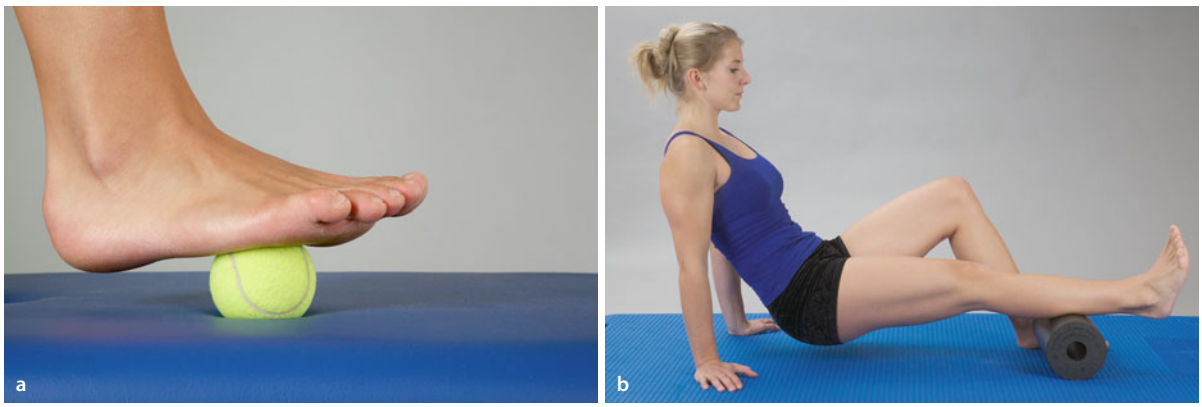


Fig. 15.2a,b Fasciae techniques (pressure and release techniques) on the pelvis and lower extremity: **a** Long plantar ligament, **b** Sciatic fasciae of thigh and lower leg

Fig. 15.3 Screw connection of rearfoot over forefoot

Fig. 15.5 Independent mobilization of the metatarsophalgeal joint by crawling the toes along the floor

case). **Cave**: No mobilization of the lower ankle joint in medial malleolar osteotomies.
- Mobilization of the tarsal bone, the lower ankle joint, the proximal and distal tibiofibular joint and the foot arch depending on findings.
- Improving the sliding ability of the tendon structure in the tendon sheath in the event of Achilles tendon sutures (Fig. 15.4).
- Checking eversion or inversion position.
- Manual therapy pelvis/lumbar spine.
- Intermittent compression to the upper ankle joint to stimulate the synovial membrane.
- Independent mobilization of the metatarsophalgeal joint by crawling the toes along the floor (Fig. 15.5), caterpillar walk while sitting: moving the foot forwards by crawling the toes.
- Careful mobilization in plantar flexion and dorsal extension of the ankle joint by:
  - Wiping movement with the foot (Fig. 15.6)
  - Rolling forwards and backwards while sitting on a Pezzi ball (full sole contact).
- **Arthrolysis:** mobilization of the upper and lower ankle joint:
  - Targeted manual joint mobilization techniques to improve the elasticity of the joint capsule: MT level 3 (against resistance!)
  - It is not possible to avoid pain completely in this case! Also supply patient with analgesics during treatment
  - Independent mobilization (Fig. 15.7a).
  - Mobilization of the superficial back and front lines
  - Mobilization of the plantar fascia with a golf ball

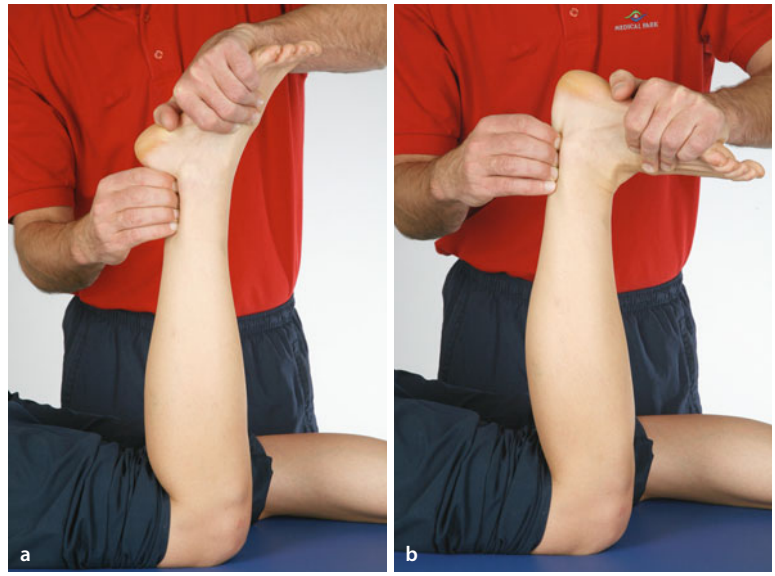


Fig. 15.4a,b Improving the sliding ability of the tendon structure in the tendon sheath in the event of Achilles tendon sutures

Fig. 15.6 Careful mobilization in plantar flexion and dorsal extension of the ankle joint by performing a wiping movement with the foot

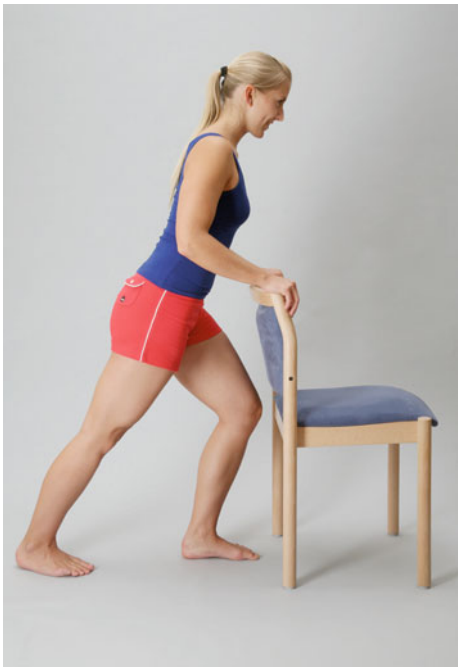


Fig. 15.8 Stretching the lower leg and foot muscles

- Mobilization of the entire fasciae from plow starting position (Fig. 15.7).
- Checking the cause-effect chain (examples see ▶ Section 15.3.1).
- Mobilization of neural structures:
  - PKB (prone knee bend)
  - SLR (straight leg raise)
    + Plantar flexion/inversion for common peroneal nerve
    + Dorsal extension/inversion for sural nerve
    + DE/E. for tibial nerve
  - Slump.
- Stretching the lower leg and foot muscles (Fig. 15.8).

Fig. 15.7 **a** Independent mobilization of the upper and lower ankle joints in the event of arthrolysis, **b** Mobilization of the entire fasciae from plow starting position

Regulation of vegetative and neuromuscular functions

- Treatment in the orthosympathetic and parasympathetic areas of origin Th8–L2, S2–S4:
  - Manual therapy, hot rolls, electrotherapy
  - Oscillation in the corresponding segments.
- Orthosympathetic slump: spine flexion + spine lateral flexion + cervical spine lateral flexion and extension.
- Treatment of potential trigger points of the entire lower extremity through INIT.
- Treatment of potential tender points of the lower extremity through SCS.
- Treatment of neurolymphatic (NLR) and neurovascular reflex points (NVR):
  - Popliteus muscle
  - Tibialis anterior and posterior muscles.

Practical tip

Neurolymphatic reflex points (NLR) for which treatment is indicated are to be distinguished from the surrounding tissue through palpation. They are usually painful and feel doughy, edematous and swollen.

- Treatment: a massage of the area without too much pain for at least 30 seconds. For very painful areas, start with gentle pressure and gradually increase pressure. A reduction in sensitivity should result from the treatment.

Neurovascular reflex points (NVR) are not as noticeable upon palpation as NLR, but can be detected by the therapist.

- Treatment: Determine NVR with two or three fingertips and gently move in different directions. The direction with the greatest tension, or where pulsation can be detected, is held for 30 seconds.

Improving sensorimotor function

- Electrical muscle stimulation: visible contraction.
- Awareness and sensitization training using stability cushion, tennis ball (Fig. 15.9), spiky massage ball, therapy lens, towel or wedge in combination with additional tasks from sitting or half-sitting position.
- Overflow training with techniques from the PNF concept in gait pattern:
  - For supporting leg activity on the side that underwent surgery:
    - Starting in supine/lateral position: leg pattern flexion adduction ER contralaterally
    - Starting in lateral position (side that underwent surgery on top): pelvic pattern of posterior depression (mid-standing) or anterior elevation (terminal standing phase)

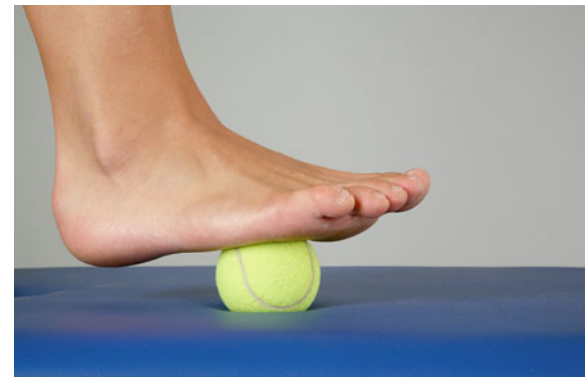


Fig. 15.9 Perception and sensitivity training using tennis ball

  - For swing leg activity on the side that underwent surgery:
    - Starting in supine position: leg pattern extension abduction IR contralaterally
    - Starting in supine position: ipsilateral leg in flexion-adduction-ER
- 3D perception of the foot position: "perpendicular heel" exercise (Fig. 15.10), foot pendulum:
  - "Perpendicular heel" exercise: direct attention to the heels
  - Starting in seated position: Alternating shifting weight to the rear of the foot: on the outside for supination and on the inside for pronation.
- PNF: Starting in quadrupedal position: flex-adduction-ER (Fig. 15.11).
- PNF to exploit the overflow from the other extremities and the core in gait pattern: e.g. the side that underwent surgery in supporting leg phase position rests against the wall in closed system (cushion, ball cushion, balance pad), starting in lateral/supine position:
  - Contralateral leg in flexion-adduction-ER
  - Ipsilateral arm in ulnar thrust
  - Ipsilateral arm in flexion-abduction-ER.

Fig. 15.10 3D perception of the foot position: "perpendicular heel" exercise

Fig. 15.11 PNF: Starting in quadrupedal position: flex-add-ER

In the event of arthrolysis

- Tai chi for physical perception, 3D movement in the ankle joint in conjunction with hip joint rotation.
- Exercising on tilt board on both legs, trampoline, large platform, (Fig. 15.12), therapy rocks (1. Eyes open, 2. Looking away, 3. Eyes closed).
- Increasing intensity of closed system isokinetics to improve intramuscular coordination (alternatively shuttle).
- Reactive single leg stabilization (e.g., lunge).
- Rotational control on instable/stable support surface.
- Travelling around a course.
- Acceleration and braking training.

Fig. 15.12 Exercising on both legs on a large platform in the case of arthrolysis

- Changing between concentric and eccentric muscle activity, e.g., the quadriceps muscle: pelvic pattern during movement transition from standing to half kneel.
- Gyrotonic.
- Strengthening/improving innervation in the muscular chains using the Redcord® system.

Stabilization and strengthening

- Isometry in plantar flexion position or neutral position and in different angle positions (in accordance with the procedure), especially for tibialis posterior muscle.
- "Knee circles" with co-contraction from lateral position (adduction, abduction in hip joint) prone position (ext. glutes) while actively stabilizing the foot.
- Strengthening the long and short foot muscles and thigh muscles (Fig. 15.13).
- Treatment of the unstable back of the foot by tensing the muscles of the longitudinal arch ("arch builder" in accordance with Klein-Vogelbach) or foot screw, 'perpendicular heel' exercise from Spiraldynamik.
- Pilates: lateral position series: e.g., raise both closed legs, keeping pelvis stable; core training, sideleg lift (Fig. 15.14).
- Leg axis training with relieved pressure: Using a mirror, the patient can visualize his/her leg axis and initially receive additional tactile support from the therapist:
  - Develop three-point weight-bearing on the foot
  - Positioning the knee joint to prevent medial collapse
  - Correction of the hip joint in front, sagittal and transverse level
  - Neutral position of the lumbar spine.

Pathology of medial collapse:

- Collapse of the longitudinal arch
- Medial rotation of the tibia and caudal tipping
- Medial rotation of the femoral condyles in the knee joint
- Adduction/external rotation or abduction of the pelvis
- Lateral flexion to the opposite side in the lumbar spine

- Leg axis training starting in sitting or half-sitting position in conjunction with additional tasks on the upper extremity (e.g., cable pulley) or with additional positioning of the foot on unstable aids, (e.g., balloon, balance board), Vitality® band (Fig. 15.15).

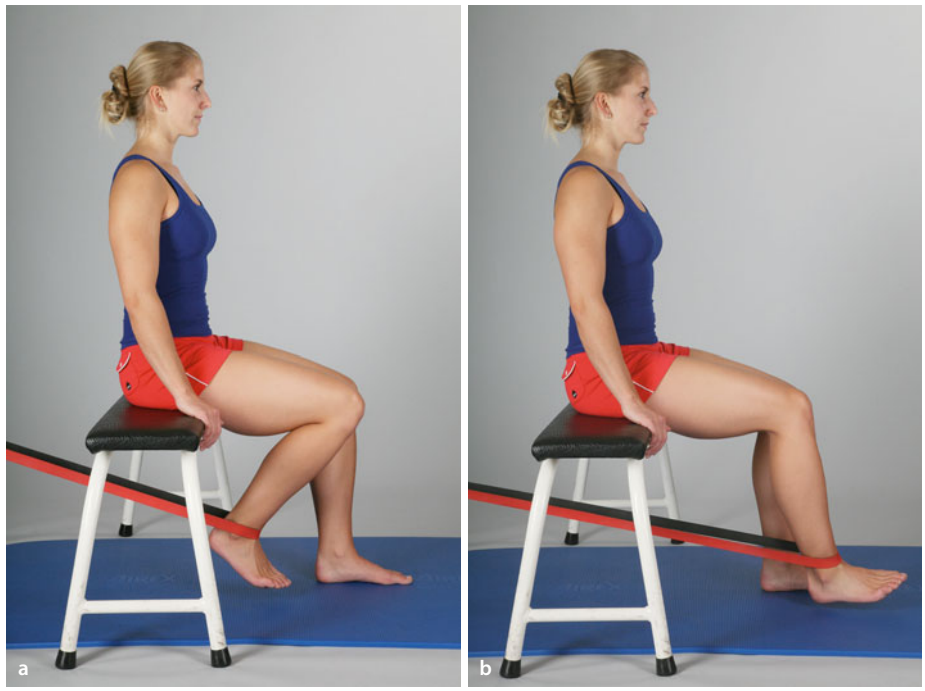


Fig. 15.13a,b Strengthening the long and short foot and thigh muscles

Fig. 15.14 Pilates: Side-lying leg lift

- Isokinetic training for plantar flexion/dorsal extension: first passively, then transition to active assisted.
- Both legs on the shuttle with low load (complete sole contact in brace).
- Squats with low range of movement.
- Training the abdominal, back and upper extremity muscles (Fig. 15.16).
- Stabilization in typical walking positions, e.g., on the tilt table.
- Both legs on the leg press/shuttle with low load (complete sole contact) (Fig. 15.17).
- Exercise pool: stabilization and mobilization exercises.

In the event of arthrolysis

- Depiction below as a seamless transition from phase II to phase IV:
- Standing on one/both legs on an unstable surface (soft mat, balance board, tilt board) with additional movements of the arms (cable pulley, Vitality® band) (Fig. 15.18).
- Stepping forwards on a stair/a step board (building up pressure) up to step-up.
- Continue strengthening in plantar flexion and dorsal extension of the ankle joint with the Vitality® band.
- Continue standing rolling activities by rolling the free leg backwards and forwards.
- Mobilization in eversion/inversion by using tilt boards.
- Continue strengthening of the entire pelvic-leg musculature.
- Continue stretch training of triceps surae muscle, the hamstring group, surface backbone (bear stance) and foot flexors.
- Continue muscle strengthening of the lower extremity using a Theraband/Deuserband
- Knee-bends/squats:
  - Two/one-leg knee bends on the leg press/shuttle with increased load (complete sole contact)
  - Two/one-leg knee bends on the leg press/shuttle with high load (complete sole contact with the floor).
  - Squats while standing with/without raising heels
  - Squats while standing with additional load.

Fig. 15.15a,b Leg axis training starting in seated position or half-sitting with additional positioning of the foot on unstable aids. **a** With ball and traction via Vitality® band, **b** Activity via the upper extremity with core involvement

Fig. 15.16 Training the abdominal, back and upper extremity muscles

Fig. 15.17 Both legs on the leg press/shuttle with low load (complete sole contact)

Fig. 15.18 Standing on one leg on an unstable surface (balance board) with additional movements of the arms

- Landing exercises:
  - Two-leg landing exercises with feet against the wall in supine position on the Pezzi ball
  - One-leg landing exercises with feet against the wall in supine position on the Pezzi ball
  - Two-leg landing exercises on the leg press/on the shuttle
  - One-leg landing exercises on the leg press/on the shuttle.
- Lunges:
  - Lunges (leg that underwent surgery forward)
  - Lunges (leg that underwent surgery forward) on unstable surface (balance pad, ufo)
  - Lunges (eccentric)
  - Lunges (eccentric-concentric)
  - Lunges (leg that underwent surgery forward) with additional load/on unstable support surface.
- Calf training:
  - On one leg/both legs as calf training on the leg press/on the shuttle/reformer
  - Calf raises on both legs while standing or on step board/stair
  - On one leg as calf training on the leg press/on the shuttle
  - Calf raises on one leg while standing or on step board/stair.
- Dynamic walking exercises:
  - Axial, dynamic-eccentric movement by stopping while walking
  - Dynamic-eccentric movement in various directions by stopping during quick walking
  - Obstacle and slalom course.
- Rolling exercises:
  - Rolling when walking under increased (axial) requirements (walking backwards, tempo, incline)
  - Rolling exercises when walking under increased (varied directions) requirements (walking sideways, spontaneous change in direction) and on uneven ground.
- Isokinetics:
  - Training plantar flexion (PF)/dorsal extension (DE) (actively-assisted)
  - Training plantar flexion/dorsal extension (active-concentric/concentric)
  - Training eversion/inversion (active-concentric/concentric).

Physical measures

- Manual lymph drainage.
- Compression bandage.
- Ice water foot baths.
- CTM: arterial leg zone; venous lymphatic vessel area, extremity.
- Cryokinetics: intermittent brief application of ice pack (cooling for 20 seconds, then activating the extremity until the skin is warm again, then repeat the cooling; 3–4 intervals).
- Electrotherapy to promote local resorption, e.g., diadynamic currents, high voltage vibration, TENS. **Cave:** Metal implants.
- Spiky massage ball, hot rolls on the sole of the foot to stimulate foot reflexology.
- Massage of the structures near the joints and associated muscle loops.
- CPM movement cast: six hours per day with repeated applications.

Gait

- Monitoring three-point or four-point walking in multiple task everyday situations: walking and talking at the same time, avoiding obstacles.
- Training the support function of the shoulder girdle:
  - Scapular pattern in conjunction with support position on parallel bars or crutches
  - Arm pattern in extension-abduction-IR
  - Instructions for independent exercises with Vitality® band
  - Plank on trowel.
- Controlling movement transitions, e.g., the patient learns to place the affected leg in front while sitting down and standing up.
- Ascend step with step-to-step technique: healthy leg in front when ascending, injured leg in front when descending.
- Therapy garden.
- Controlling three-point foot weight-bearing as a basis for the leg axis, with static core involvement at the end of the phase.
  - Task: Imagine that there is a tensed band between the heel and the metatarsophalangeal joint of the big toe that you want to push forwards with the heel. The tension should be built up without the contraction of the tibialis anterior muscle where possible.
- Leg axis training with relieved pressure: Using a mirror, the patient can visualize his/her leg axis and initially receives additional tactile support from the therapist:
  - Develop three-point weight-bearing on the foot
  - Positioning the knee joint to prevent medial collapse
  - Correction of the hip joint in front, sagittal and transverse level
  - Neutral position of the lumbar spine.
- Load control on the force measurement plate.

Fibular and pelvic position must be checked regularly and treated during diagnostics: ilium rotations, up slip or down slip, sacrum misalignments. Also consider visceral connections. Anterior ilium rotation: iliacus muscle – pelvic organs; posterior pelvic rotation: psoas muscle – abdominal organs.

In the event of arthrolysis

- Controlling gait under partial or full load in multiple task situations: walking and talking at the same time, avoiding obstacles.
- Use of visual (mirror, floor markings) and acoustic (rhythmic tapping) aids.
- Increasing the simulation of everyday strains (e.g., walking in the walking garden with additional tasks) with different coordination options (backwards, sideways, slowly, quickly) on different ground surfaces.
- Increasing the exercise duration on the treadmill while checking in mirror.
- Video gait analysis as feedback training for the patient.

15.2.2 Medical training therapy

- General accompanying training of the core and the upper extremity: dip trainer, lat pull, bench press, rowing, crunches, back extension.
- Endurance training on three-point ergometer without extremity concerned, insofar as load bearing capacity has not been reached.
- Ergometer training: 1 × 10 up to 2 × 15 mins with low load: 20–50W, potentially with shortened crank, also possible with brace.
- Gait training.

Sensorimotor function training

Sensorimotor function training principles

- **Static training:**
  - Load time: 5–30 seconds
  - Number of repetitions: 10
  - Number of exercises: 1–4
- **Dynamic training:**
  - Number of repetitions: 10–20
  - Series: 1–3
  - Number of exercises: 1–4

In sensorimotor training, the quality of the execution of the movement is of great importance. Here, it is particular important to consider:

- **Loss of active stabilization (foot control, leg axis, core stability)**
- **Coordination disorder**
- **Muscle tremors**
- **Decrease in concentration**

- Working out the leg axis within the permitted load and range of motion:
  - Mini knee-bends on both legs up to max. 60° flexion in the knee joint on "Keilholz" (preventing dorsal extension)
  - Pilates: reformer training in the form of leg presses with 10–15kg load, as soon as the load is permitted for the endoprosthetic (from 7th week), heel strike.
- Developing standing stabilization (level surface, later also unstable/stable):
  - Bearing weight standing parallel on both legs, on a wedge-shaped surface
  - Bearing weight while stepping forward on the front leg (not in the case of cartilage therapy).

Strength training

- Intramuscular activation via isometry
  - Strength endurance training (adjusted to plans; focus on local stabilizers; 4 × 20 (-50) repetitions within absolutely pain-free range!)
  - Overflow via the contralateral side as strength endurance training; 4 × 20 repetitions
  - Training hip joint stabilizers:
    - Flexion/extension (slides in supine position; leg lifts in prone position on bench)
    - Abduction/adduction (sliding on slideboard/tile) (Fig. 15.19).
- Training knee joint stabilizers:
  - Flexion (Vitality® band slides while sitting from extension with tile under the heel)
  - Extension (stretching via supported position from 20° flexion into full extension, without load)
  - Flexion/internal rotation

Fig. 15.19 Training hip joint stabilizers: Abduction/adduction

Fig. 15.20 Training knee stabilizers: Flexion/extension on the equipment

- Training knee stabilizers: flexion/extension on the equipment (Fig. 15.20) or cable pulley, guiding thigh in the open system.
- Training ankle joint stabilizers:
  - Plantar flexion (Vitality® band, lower leg supported, free ankle joint) (Fig. 15.21)
  - Dorsal extension (Vitality® band) only once approved, primarily from plantar flexion position isometrically
  - Eversion/inversion isometrically, strength endurance with Vitality® band, from sitting on the floor via stable ankle joint with internal/external rotation from the hip.

Fig. 15.21 Training ankle joint stabilizers: plantar flexion with Vitality® band, lower leg supported, free ankle joint

15.3 Phase III

Goals (in accordance with ICF)

Goals of phase III (in accordance with ICF)

- **Physiological function/bodily structure:**
  - **Improvement in functions affecting sensorimotor function**
  - **Restoration of joint mobility**
  - **Restoration of muscular strength**
  - **Optimization of joint stability**
  - **Optimization of a coordinated movement pattern along the kinematic chain during movement**
  - Promoting resorption
  - Avoiding functional and structural damage
  - Regulation of impaired vegetative and neuromuscular functions
- **Activities/participation:**
  - Developing dynamic stability when walking, while observing load guidelines
  - Optimization of the support function, core and pelvic stability in movement
  - Independence when meeting the challenges of daily routines
  - Exploiting the limits of movement and load at work and in sport
  - Learning a home training program

15.3.1 Physiotherapy

Patient education

- Information regarding existing restrictions in **tendon repair**:
  - From approx. 4 months post-op, beginning with running training
  - From 12th week and with at least 80% of force on the contralateral side: beginning with weight-supported jump variants.
- Information regarding existing restrictions in **cartilage treatment**:
  - Begin with running training on an even surface approx. 3 months post-op.
- Information regarding recommendations for **endoprosthetics**:
  - No jumping
  - In general, avoid high-risk sports
  - Start with swimming, stationary bicycle from approx. 7th week post-op
  - From approx. 4 months post-op: cycling
  - No jogging.

Fig. 15.22 Fascia techniques (pressure and release techniques) on the pelvis and lower extremity: Fascia lata

Fig. 15.23 Mobilization of the tarsal bone

- Discussing the content and goals of treatment with the patient:
  - Instruction in a home training program to continue stability training, thus preventing relapse.

Promoting resorption

- Elevation.
- Active decongestion exercises.
- Manual lymph drainage.
- Compression bandage.
- Contrast baths.

Improving mobility

- Soft tissue treatment:
  - Treatment of the surrounding muscles: gastrocnemius muscle, soleus muscle, long foot muscles, peroneal muscles, tibialis anterior muscle through INIT, strain counterstrain (SCS), post-isometric relaxation (PIR), contract-relax, muscle energy technique
  - Fascia techniques (pressure and release techniques) on the pelvis and the lower extremity, e.g., long plantar ligament, fascia cruris, lateral thigh fasciae, ischiatic fascia on the thigh and lower leg, fascia lata (Fig. 15.22).
- Mobilization of the tarsal bone (Fig. 15.23), of the tibiofibular joint distally and proximally, lower ankle joint, upper ankle joint, primarily in dorsal extension.
- Mobilization of the surrounding joint where necessary: sacroiliac joint, hip joint, lumbar spine, knee joint.
- Automobilization of the metatarsophalgeal joint by crawling the toes along the floor, caterpillar walk while sitting: crawling the foot forwards by crawling the toes.
- Checking the eversion or inversion position of the calcaneus and training on the edge of a surface (Fig. 15.24), e.g., a wooden board.

Fig. 15.24 Checking eversion or inversion position of the calcaneus and training on the edge of a surface

- In the case of previous inversion or eversion trauma, particular attention should be paid to the examination of the ascending chain of cause and effect (see following overview for examples).

Ascending chain of cause and effect: examples

- Primary lesion is an inversion trauma:
  - Cuboid bone held in ER
  - Fibula translated caudally
  - Thereby influence on:
    - Site of the emergence of the interosseous membrane bundle of vessels and nerves
    - Stretching biceps femoris muscle (posterior ilium rotation)
    - Impact on iliotibial tract

  - Ilium-posterior rotation leads to hypertension of the homolateral paravertebral muscles
  - Stretching sacrotuberous and sacrospinal ligaments
  - Base of sacrum bone homolaterally relatively anterior
  - Torsion in the upper ankle joint (ER tibia - IR talus bone)
  - Problems when standing through ilium fixation.
- Primary lesion is an eversion trauma:
  - Internal rotation of the tibia and talus bone slides antero-internally
- Valgus position of the calcaneus bone and forefoot, abduction-supination movement
  - Medial foot arch flattens
  - Endorotation of the lower leg
  - Valgus in the knee
  - Endorotation of thigh and hip
  - Anterior ilium bone
  - Stretching of iliolumbar ligament.

- Mobilization in plantar flexion and dorsal extension of the ankle joint:
  - Wiping movement with the foot
  - Rolling forwards and backwards on a Pezzi ball with full sole contact.
- Combined compression, mobilization or oscillation technique, 3-5 sets with 20 reps. Active breaks through active-assisted movement of the joint; axial compression, later with mobilization.
- Mobilization of neural structures:
  - PKB (prone knee bend)
  - SLR (straight leg raise)
    + Plantar flexion/inversion for common peroneal nerve
    + Dorsal extension/inversion for sural nerve
    + DE/Ev for tibialis posterior nerve
  - Slump.
- Screw connection of rearfoot over forefoot.

Regulation of vegetative and neuromuscular functions

- Mobilization in the orthosympathetic and parasympathetic areas of origin Th8–L2, S2–S4: e.g., with manual therapy, oscillations in the corresponding segments, electrotherapy.
- Treatment of potential trigger points with techniques in accordance with Simons/Travel or INIT: Lower leg, ankle and foot.
- Orthosympathetic slump.
- Treatment of neurolymphatic (NLR) and neurovascular reflex points (NVR):
  - Popliteus muscle
  - Tibialis anterior and posterior muscles.

Improving sensorimotor function

- Tai Chi: bear stance, vertical Tai Chi circle.
- Leg axis training: using a mirror, the patient can visualize his/her leg axis and initially receives tactile support from the therapist:
  - Develop three-point weight-bearing on the foot
  - Positioning the knee joint to prevent medial collapse

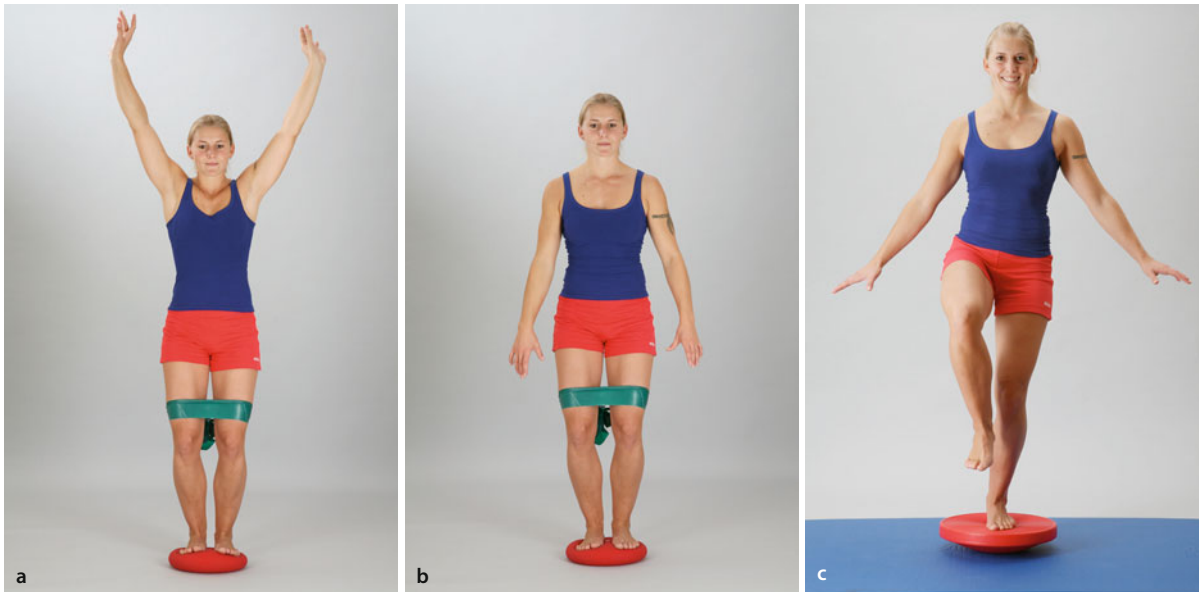


Fig. 15.25a–c Exercising on one leg **a,b** On the ball cushion, **c** On the balance board

Fig. 15.26 Reactive one-leg stabilization: lunge on the mat

- Correction of the hip joint in front, sagittal and transverse level
- Neutral position of the lumbar spine.

- Single-leg exercising on tilt board, large platform, ball cushion (Fig. 15.25a,b), balance board (Fig. 15.25c).
- Therapy rocks: step stabilization.
- Closed system isokinetics to improve intramuscular coordination (alternatively shuttle).
- Reactive single leg stabilization, e.g., lunge on mat (Fig. 15.26), increase through additional task: catching a ball
- Rotational control on unstable/stable support surface (Fig. 15.27).
- Course with varying surface, speed.
- Acceleration and brake training.
- Strengthening/improving innervation in the muscular chains by exercising using the Redcord® system.
- Eccentric training of the pretibial muscles using a Vitality® band (Fig. 15.28).
- Starting position for eccentric training of the triceps surae muscle: standing on tiptoes on a stepper. Hold starting position for two seconds, then lower until or to below horizontal level, 3 x 15 reps.

Stabilization and strengthening

Depiction below as a seamless transition from phase III to phase IV:

- Strengthening plantar flexion:
  - Sitting + weight (heel raise) (Fig. 15.29a)
  - Tiptoes on both legs (Fig. 15.29b,c)
  - Start from pre-stretching
  - Standing on tiptoes on one leg
  - Standing on tiptoes on one leg + pre-stretching
  - All exercises with flexed or straight knee joints for gastrocnemius muscle or soleus muscle.

Fig. 15.27a,b Rotational control on unstable/stable support surface

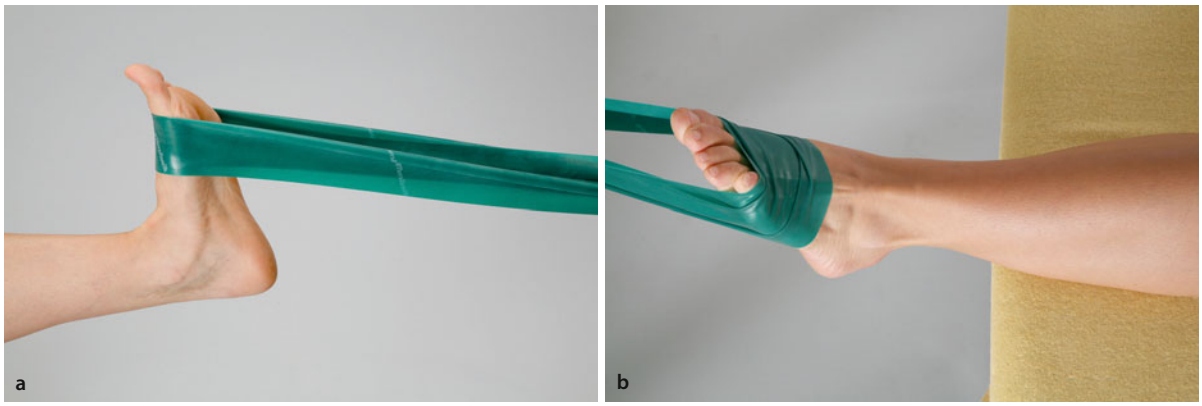


Fig. 15.28a,b Eccentric training of the pretibial muscles using a Vitality® band

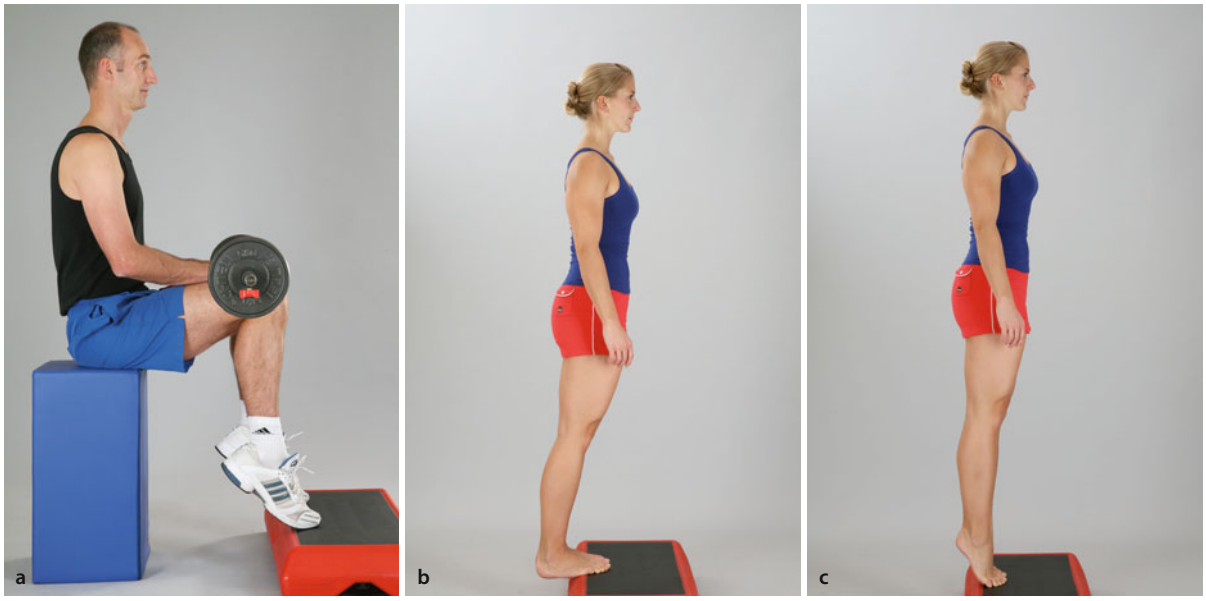


Fig. 15.29a–c Strengthening plantar flexion. **a** Sitting + weight (heel raise), **b,c** Standing on tiptoes on both legs

- Calf training:
  - On one/both legs as calf training on the leg press/on the shuttle
  - Calf raises on both legs while standing or on step board/stair
  - On one leg as calf training on the leg press/on the shuttle (Fig. 15.30)
  - Calf raises on one leg while standing or on step board/stair.
- Standing on one/both legs on an unstable surface (soft mat, balance board, tilt board) with additional movements of the arms (cable pulley, Vitality® band) (Fig. 15.31).
- Stepping forwards on a stair/a step board (building up pressure) up to step-up.

Fig. 15.30 On one leg as calf training on the leg press/on the shuttle

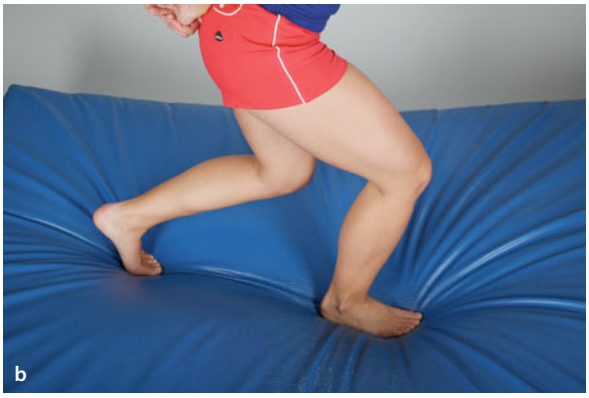


Fig. 15.31a,b Standing on one/both legs on an unstable surface **a** Tilt board with additional movements of the arms, e.g., juggling, **b** Soft mat, lunge

- Continuous training for the core and upper body.
- Continuous strengthening of the entire pelvic/leg musculature while resting the structures concerned.
- Stretching: triceps surae, hamstring group, surface backbone (bear stance), dorsiflexors (Fig. 15.32).
- Lunges:
  - Lunges: leg that underwent surgery forward
  - Lunges (leg that underwent surgery forward) on unstable surface (Fig. 15.33a,b)
  - Lunges (eccentric) (Fig. 15.33c)
  - Lunges (leg that underwent surgery forward) with additional load/on unstable surface (Fig. 15.33d)
  - Lunges (eccentric-concentric).

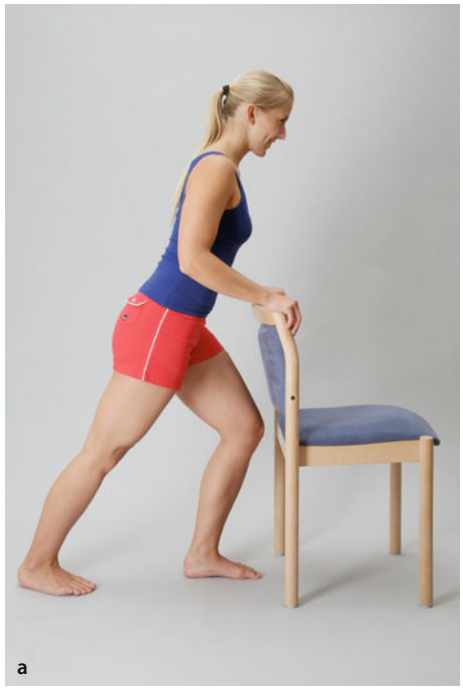


Fig. 15.32a,b Stretching triceps surae muscle, hamstring group

- Knee-bends/squats:
  - Two/one-leg knee bends on the leg press/shuttle with high load (complete sole contact with the floor
  - Two/one-leg training on the leg press or on the shuttle with increased load and complete sole contact with the floor (Fig. 15.34a)

Fig. 15.33a–d Lunges **a,b** On an unstable surface, **c** Eccentric, **d** With additional load on unstable ground. The leg that underwent surgery should be in front

- Two/one-leg knee bends on the leg press/shuttle with high load (complete sole contact with the floor) using unstable support surfaces (Fig. 15.34b)
- Squats while standing with/without raising heels
- Squats while standing with additional load.
- Landing exercises:
  - Two-leg landing exercises against the wall from supine position on the Pezzi ball (Fig. 15.35)
  - Two-leg landing exercises on the leg press/on the shuttle
  - One-leg landing exercises with feet against the wall in supine position on the Pezzi ball

Fig. 15.34a,b Two/one-leg knee bends **a** On the leg press/shuttle with high load with complete sole contact with the floor, **b** Using unstable support surfaces

Fig. 15.35 Two-leg landing exercises against the wall from supine position on the Pezzi ball

- One-leg landing exercises on the leg press/on the shuttle.
- Rolling exercises:
  - Rolling when walking under increased (axial) requirements (walking backwards, tempo, incline)
  - Dynamic-eccentric movement, axial by stopping while walking
  - Dynamic-eccentric training, in various directions by stopping during quick walking
  - Obstacle and slalom course.
- Isokinetic training:
  - Plantar flexion (PF)/dorsal extension (DE) (active-assisted)
  - Plantar flexion/dorsal extension (active-concentric/concentric)
  - Eversion/inversion (active-concentric/concentric).
- Initial stabilization on climbing rocks for pronators and supinators (Fig. 15.36).

Physical therapy

- Massage of the structures near the joints and associated muscle loops.
- Functional massage of the lower extremity.
- Reflexology: Marnitz therapy, foot reflexology massage, connective tissue massage.
- Hot rolls.
- Acupuncture massage: energetic treatment of the scar.

Gait

- Improving and economizing gait.

Practical tip

Developing gait

- The walking cycle is divided into sequences, and the individual movement components are performed in isolation.
  - Example: the activation of the plantar flexion/pronating twisting when there is no transition from mid-standing to terminal standing phase. Firstly, standing on tiptoes is developed with controlled load on the metatarsophalangeal joint of the big toe.
  - For example as a partial task, the patient exercises the terminal supporting leg phase using parallel bars, for example, while simultaneously

Fig. 15.36a,b Initial stabilization on climbing rocks for pronators and supinators

swinging contralaterally (leg pattern in flexion-adduction-ER)
- The sequence is then integrated into the overall movement process of supporting leg phases.

- Walking training on the treadmill in front of a mirror.
- Dynamic walking exercises:
  - Dynamic-eccentric, axial movement by stopping during walking
  - Rolling when walking under increased (axial) requirements (walking backwards, tempo, incline)
  - Rolling exercises when walking under increased (varied directions) requirements (walking sideways, spontaneous change in direction) and on uneven ground
  - Dynamic-eccentric training, in various directions by stopping during quick walking/running
  - Obstacle and slalom course.
- Develop three-point weight-bearing on the foot
  - Positioning the knee joint to prevent medial collapse
  - Correction of the hip joint in front, sagittal and transverse level
  - Neutral position of the lumbar spine.
- Intensification of training to improve perception, adapted to potential new strains:
  - Walking on different surfaces with visual and acoustic distractions
  - Walking in walking garden/course while holding a conversation
  - Opening an umbrella
  - Singing a song
  - Coordinative variations (backwards, sideways, slowly, quickly, different directions)
  - Differing illumination (simulation of everyday situations).
- Reaction and braking test in therapy car.
- Economizing gait in terms of stride length, rhythm, tempo.
- Use of visual (mirror, floor markings) and acoustic (rhythmic tapping) aids.
- Video gait analysis as feedback training for the patient.
- Walking on the force measurement plate for load control: Is load borne on the side that was operated on?
- Walking against resistance, Vitality® band, cable pulley.

Monitoring leg length: Is there an anatomical or functional difference in leg length? Also consider orthopedic or podo-orthesiological insole treatment!

- Balance training on different unstable surfaces, beginning with change of rhythm.

15.3.2 Medical training therapy

- General accompanying training of the core and the upper extremity.
- Gait training: weaning off crutches.

Fig. 15.37a,b Sport-specific conditioning. **a** Soccer instep with light ball, **b** Lunges with inline skate

Sensorimotor function training

- Developing the stabilization of the leg axis under variable conditions, including with medium loads: e.g., standing stabilization on unstable surface with lateral cable pulley load, angled tilt board, stepping with affected leg forwards on the tilt board, pull cable pulley laterally.
- Developing stabilization on one leg
  - Single-leg load bearing (e.g., free leg phase with step combination)
  - Developing foot stabilization and dynamic movement: e.g., spiral dynamic screw connection of the foot, load distribution training of the foot in dynamic situations, e.g., side step
  - Squats within full range of motion, on one leg while checking in mirror.
- Developing walking alphabet:
  - Step combinations from standing
  - Ankle workout while standing: e.g., rolling from toes to heel
  - Running on forefoot with small amplitude, slowly forwards
  - Side steps (step to the side with brief stabilization phase).
- Working on jumps (not in the case of endoprosthetics):
  - Jump – land
  - Jump – open eyes = land
  - Close eyes – jump – land
  - On two legs – on one leg
  - With stretch 1/4, 1/2, 3/4, 360°
  - Landing on unstable surfaces.
- Step-forwards with training in the landing phase and braking function.
- Two-legged jumps outwards: e.g., jumping onto level steps).
- Training eccentric muscle activity: calf raises on the step, step-downs for functional involvement.
- Feedback training, also with medium loads: e.g., standing stabilization on proprio-swing system, with variable levels (plantar/dorsal tilts; inversion/eversion tilts, diagonal planes).
- Sport-specific conditioning: side-step tennis, soccer instep with light ball (Fig. 15.37a), lunges with inline skate (Fig. 15.37b), rebound jumps in basketball, fall training.
- Endurance strength training, as warmup exercise for the local stabilizers, see phase II, ▶ Section 15.2.2.
- Hypertrophy training for general musculature with medium range of motion, in completely pain-free range! 6 × 15 reps, 18/15/12/12/15/18; as pyramid.
- Squats, ab/adductor training, training the core and gluteal muscles, leg presses, hamstring curls.
- Ergometer training 20–30 mins with increasing duration and wattage depending on physical condition.

- Treadmill exercise: uphill walking with 10% incline at a speed of 3-5km/hour for 10-20 minutes
- Stepper.

Therapeutic climbing

- Initial stabilization in neutral ankle joint position in vertical wall area with traction support on large steps and:
  - From slightly inverted/everted position
  - In positive wall area with limited hand support
  - On small steps.
- Free bouldering in low area of the wall.

15.4 Phase IV

15.4.1 Sports therapeutic content for the lower extremity

General

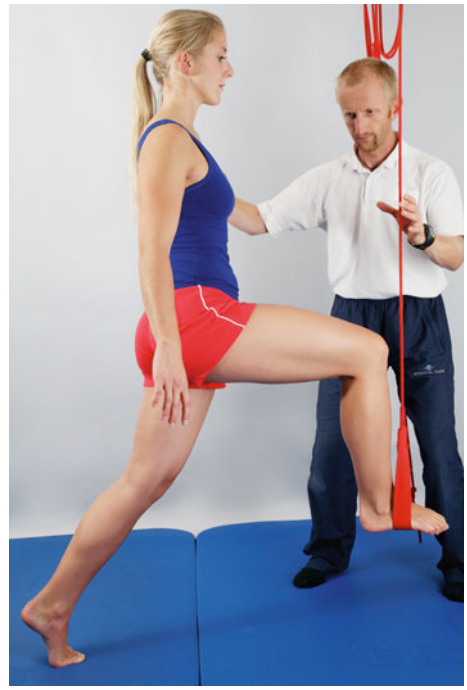
- Determining intensity through a one-rep maximum.
- Spreading strength training units over muscle groups and different days.
- Observing classic training principles.
- Inclusion/coordination with competition planning/periodization.
- Controlling load via the sequencing of various exercises rather than series of exercises, e.g., calf raises, squats, jumps.

Sensorimotor function training

- Integration into each training unit following the warm-up stage.
- Integrate sport-specific exercises into each training session. Physical awareness from sport-specific movement (own internal error analysis), comparing errors in own/external and video analysis:
  - Unstable environments, increased requirements (e.g., one-legged knee-bends on Redcord®, ◘ Fig. 15.38; juggling while pedalo boating, Redcord® training).
  - Feed forward training e.g., passing balls of different weights or sizes, landing with eyes closed, landing on unknown (visually obscured) surface.

Strength training

- General accompanying training of endurance as well as the core and the upper extremity.
- Strength endurance training of the local stabilizers (transverse abdominal muscle, multifidus muscles, pelvic floor muscles in the warm-up phase:
  - Preparing for exercise by practicing the type of load with a lower weight



◘ **Fig. 15.38** Unstable environments, increased requirements: one-legged knee-bends on the Red-cord®

  - Training of the local stabilizers (dynamically as functional endurance performer, high number of repetitions with low intensity), ankle/knee/hip joint stabilizers.
- Maximum strength training of the global muscles (two to three times per week):
  - Intramuscular coordination training (full range of motion, 6 × 3-5 reps):
    Machine-supported: leg presses, hamstring curls
    Weights training: knee-bends (squats and variants, lunges and variants) (◘ Fig. 15.39), calf raises
  - Speed and explosive strength training (e.g., sprints, sprint starts)
  - Explosive loads (positive jumps, spider jumps)
  - Working on jumps:
    Jump – land
    Jump – open eyes = land
    Close eyes – jump – land
    On two legs – on one leg
    With stretch 1/4, 1/2, 3/4, 360°
    Landing on unstable surfaces
    Step-forwards with training in the landing phase and braking function
    Two-legged jumps outwards (e.g., jumping onto level steps).
- Reactive loads (counter-movement jumps (◘ Fig. 15.40), drop jumps, changing direction while running, stop and go).

Fig. 15.39 Intramuscular coordination training: weights training with knee-bends (squats and variants)

- Reactive-situative loads (Fig. 15.41), plyometry training, training in the stretch-shortening cycle (SSC): e.g., landing from jumps, goal training, cross country runs, stop and go.
- Development of condition variables: precision control (e.g., line jumps, ball control) (Fig. 15.42), time control (e.g., tapping, skipping), situation control (e.g., choice of responses to a signal, complexity control).
- Multi-directional training from variable starting positions, lunges with load and unstable surface.

Develop sport-specific training methods methodically

- e.g., soccer:
  - Instep while standing with light ball on throw in (Fig. 15.43)
  - Instep while standing with normal ball on throw in
  - Instep from the passing movement with side step
  - Instep from movement with variable passing forwards, backwards, sideways
  - Instep with choice of right/left leg as supporting leg
  - Instep under precision pressure (catching a ball)
  - Instep under time pressure (two balls in quick succession)
  - Instep under situational pressure (pass to various positions than choices, short pass, long pass, slow pass, fast pass)
  - Passing while under complexity pressure (with opponent).
- Sport-specific competitive training.

Therapeutic climbing

- Variable climbing training with lead climbing situation (Fig. 15.44).

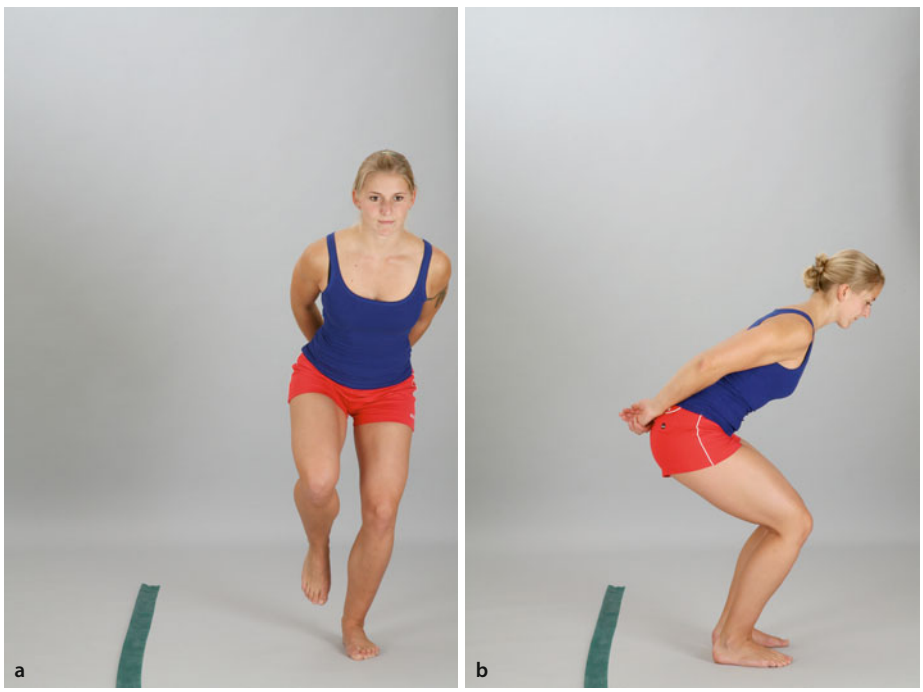


Fig. 15.40a,b Reactive loads: various jump variants

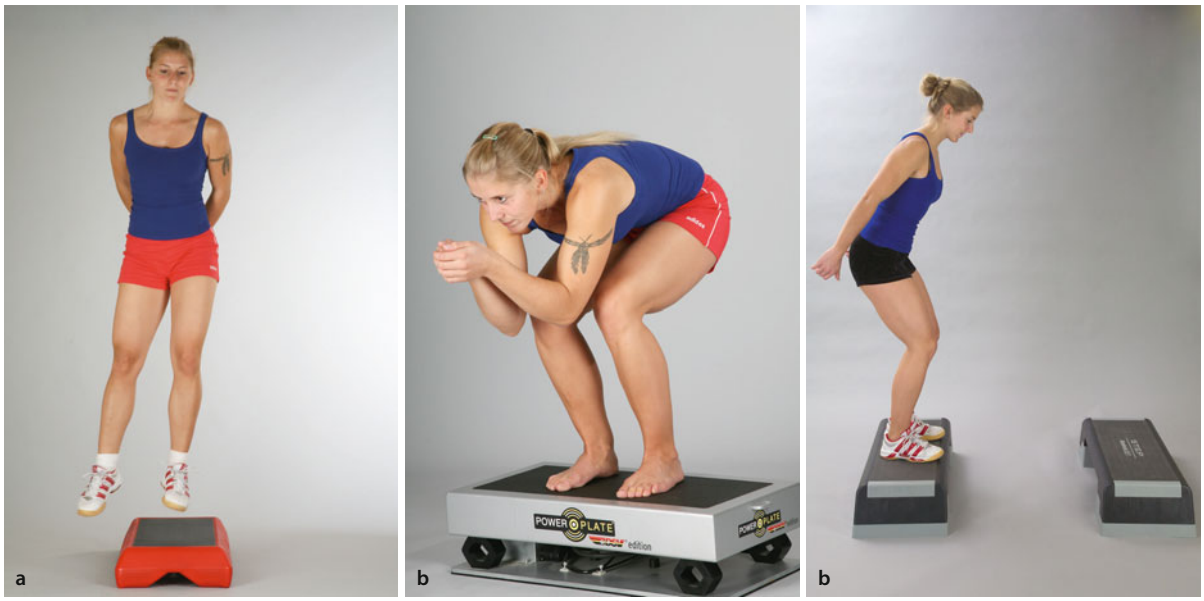


Fig. 15.41a–c Reactive-situative loads

Fig. 15.42 Development of condition variables: precision control

Fig. 15.43 Instep while standing with light ball on throw in

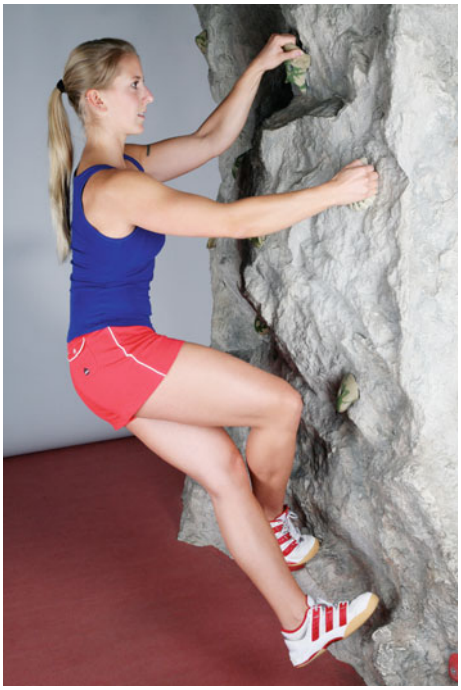


Fig. 15.44 Variable climbing training with lead climbing situation

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Spine

Strategy for the rehabilitation of the spine (stages I-IV)

- Safeguarding the result of the surgery:
  - Patient education
  - Anatomical, biomechanical, pathophysiological and neurophysiological knowledge (wound healing phases, tissue regeneration time)
  - Knowledge of the surgical procedure
  - Patient/athlete compliance.
- Learning segmental **stabilization,** physiological temporal innervation program (feed forward system), cranio-cervical flexion test (primarily improvement in the endurance of the deep cervical spine flexors):
  - Extension static stabilization
  - Rotation static stabilization
  - Lateral static stabilization.
- Damping/inhibiting inhibitory afferent nerve pathways.
- Sensorimotor function/coordination training.
- Axial compression.
- Improving mobility in the surrounding structures.
- Learning segmental **movement control**:
  - Flexion/extension movement
  - Lateral flexion movement
  - Rotation movement.
- Learning segmental **movement control**:
  - Eccentric rotary movements in extension
  - Eccentric rotary movement in flexion.
- Throws.
- Jumps.
- Everyday or sport-specific training.

Weighting of treatments over the different phases

	Phase II	Phase III	Phase IV
Physiotherapy	25%	15%	10%
Sensorimotor function	25%	35%	10%
Strength training	10%	20%	35%
Sport-specific training	10%	10%	30%
Exercising local stabilizers	30%	20%	15%

Cervical spine: Surgical procedure/aftercare

Andreas Imhoff, Knut Beitzel, Knut Stamer, Elke Klein

A. Imhoff et al. (Eds.), *Rehabilitation in Orthopedic Surgery*,
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16.1 Intervertebral disc surgery

16.1.1 Cervical spine intervertebral disc prosthetic

Indication

- Symptomatic instability in the case of degenerative disk disease.
- Post-discectomy syndrome.
- Recurring prolapse.
- Prolapse within the area of the cervical spine.

Surgical method

- Holding the patient in supine position, spine in neutral position.
- Surgical access via an anterolateral access (lateral to trachea/esophagus, medial to the major vessels).
- Resection of the intervertebral discs affected (discectomy) and decompression.
- Restoring the desired height of the intervertebral disc space using a distractor.
- Removing any osteophytes and the cartilaginous endplate while preserving the cortical bone.
- Measuring the correct implant size and inserting the sample implant under radioscopy screening.
- Preparation of the prosthesis with the aid of prosthesis/specific instruments.
- Inserting the final implant under BV control in press-fit technique.
- Wound closure layer by layer.

Aftercare

Table 16.1 provides an overview of aftercare.

16.1.2 Laminectomy/decompression

Indication

- Degenerative spinal canal stenosis.

Surgical method

- Radiological localization of the affected segment(s).
- Strictly central longitudinal incision via the spinal segment concerned.
- Shifting the back extensor muscles from the spinous processes to the vertebral arches.
- Exposing the spinous processes, lamine and vertebral joints.
- Resection of the spinous processes of the segments affected.
- Careful exposure of the spinal section with outgoing nerve routes through laminectomy.
- Subsequent spondylodesis in the event of developing or threatening instability (▶ Section 16.2.1).
- Wound closure layer by layer.

Aftercare

Table 16.2 provides an overview of aftercare.

16.2 Stabilization

16.2.1 Spondylodesis ventrally/ vertebral replacement

Indication

- Destruction of multiple intervertebral spaces.

Table 16.1 Cervical spine intervertebral disc prosthetic. Possible Cervical support for approx. seven days

Phase	Range of motion and permitted load	
I	from 1st day post-op:	Mobilization depending on pain situation with cervical support
II	from 6th week post-op:	Cycling, start of running training
III		
IV	approx. 3 months post-op:	Sport-specific training

Table 16.2 Laminectomy/decompression. Lumbotrain brace

Phase	Range of motion and permitted load	
	from 1st day post-op:	Mobilization depending on pain situation

Table 16.3 Spondylodesis ventrally/vertebral replacement. Chairback brace

Phase	Range of motion and permitted load	
	from 1st day post-op:	"En bloc" rotation allowed. Standing in front of the bed Followed by slow mobilization with Chairback brace No deep sitting for six weeks post-op in the case of spondylodesis of the lumbar spine Radiological examinations from six weeks post-op
	from 12 weeks post-op:	Following consolidation of the spondylodesis, wean off chairback brace. Increasingly free mobilization. Sport after six months at the earliest in the case of consolidated spondylodesis and freedom from discomfort

Surgical method

- Access transcervically, retroperitoneally or transthoracically depending on the height of the defect concerned.
- Removal of one or more vertebral body and insertion of a placeholder: e.g., cages, distractable vertebral body replacement or autologous bone (iliac crest bone graft, rib or fibula).
- Stabilization of the neighboring segments through bridging osteosyntheses.
- Additional dorsal stabilization in the event of longer bridging.
- Wound closure layer by layer.

Aftercare

Table 16.3 provides an overview of aftercare.

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Cervical spine: Rehabilitation

Andreas B. Imhoff, Knut Beitzel, Knut Stamer, Elke Klein

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17.1 Phase I

Phase I of the rehabilitation is identical for cervical spine, thoracic spine and lumbar spine.

Goals (in accordance with ICF)

Goals of phase I (in accordance with ICF)

- **Physiological function/bodily structure:**
  - **Pain relief/management**
  - **Avoiding functional and structural damage**
  - **Improving core stability/muscular corset**
  - Promoting resorption
  - Improvement in functions affecting sensorimotor function
  - Regulation of impaired vegetative and neuromuscular functions
- **Activities/participation:**
  - Learning change of position as needed for surgery
  - Correction of improper posture and movement pattern
  - Developing active coping strategies for dealing with pain
  - Hints and tips for independence when meeting the challenges of daily routines
  - Learning a home training program
  - Promoting mobility (maintaining and changing body position, walking and movement)
  - Breaking down barriers that impede participation (anxiety)

17.1.1 Physiotherapy

Patient education

- Discussing the content and goals of treatment with the patient.
- Providing the patient with further information regarding the limitations associated with the operation.

The following are forbidden:

- **Deep sitting in the case of lumbar spine surgery**
- **Mobilization/movements within surgical area**
- **Rotation within area where surgery occurred**
- **Lifting heavy loads**

- Learning the movement transfer/switching position from supine position to lateral position, standing while avoiding movements in the surgical area: en bloc rotation.
- Strategies for putting on and taking off clothes, washing, tying shoe laces; coughing/sneezing.
- Tips to relieve pressure should discomfort/pain arise (e.g., remain in supporting position with cushions in lateral position).
- Explain the necessity of performing consistent independent exercises.

Prophylaxis

- Adopting a vertical position on 1st or 2nd day post-operative day, in conjunction with working on a level surface.
- Instruction on SMI trainer, deep breathing techniques such as nose stenosis, "sniffing" inhalation, breathing control.
- Active terminal movement in the ankle joints or wrists at second intervals.
- Active movement of the upper extremity for lumbar/thoracic spine surgical procedures or only hand and elbow in the case of the cervical spine.

The exercises should be performed independently once per hour as local endurance training (aerobic)!

Promoting resorption

- Manual lymph drainage.
- Hot rolls.
- Breathing therapy.
- Major abdominal maneuver (decongestion).

Improving mobility

- Improving joint mobility depending on findings: OAA complex (occiput-atlas-axis), thoracic spine, rip joints, shoulder and hip joints with manual therapeutic measures.
- Regulation of pelvic/sacroiliac joint misalignments (e.g., rotations of the ilium, sacral misalignment) (**Cave:** Continuing movement of the lumbar spine).
- Craniosacral therapy depending on findings: e.g., "still point" induction on the sacrum. Still point induction leads to the balancing of the tension in the tissue and fasciae.
  Technique: The palms of the hand lie below the sacrum, with the fingertips pointing cranially. The therapist pursues the movement with the greatest movement amplitude (e.g., extension movement of the sacrum) and applies gentle resistance to the diminished movement. Following a number of cycles, a still point is reached, i.e., the tissue relaxes. The therapist dwells on this point until movement resumes (Fig. 17.1).
- Checking foot and fibula position: The fibula serves as an indicator as to whether an ascending or descending cause-effect chain exists = influence of ilium rotation.

Fig. 17.1 Craniosacral therapy

Fig. 17.2 Exploiting the overflow via the upper extremity with short lever through techniques from the PNF concept while controlling muscular tension via a pressure feedback unit (PBU)

Regulation of vegetative and neuromuscular functions

- Treatment in the orthosympathetic and parasympathetic areas of origin C8–L2 as well as OAA complex and S2–S4:
  - Manual therapy: mobilization of the thoracic spine and the rib joints
  - Physical therapy: massage, hot rolls, electrotherapy, connective tissue massage.
- Treatment of neurolymphatic and neurovascular reflex points:
  - Latissimus dorsi muscle
  - Gluteus maximus muscle
  - Iliopsoas muscle
  - Neck flexors and extensors
  - Trapezius ascendens muscle.
- Craniosacral therapy: CV4 technique to reduce tone of sympathetic nervous system.

Improving sensorimotor function

- Minimal dose of compression level 1 from MT as afferent sensomotory input.
- Exploiting the overflow via upper (lumbar spine) and lower (cervical spine) extremity with short lever through techniques from the PNF concept to facilitate the physiological activation of functional muscle chains (Fig. 17.2). Controlling muscle tension using a pressure biofeedback unit (PBU).
- Awareness training: e.g., feldenkrais, ideokinesis.
- Eye movement: head-eye coordination.

Stabilization and strengthening

- Developing core stability, e.g., via:
  - PNF pelvic pattern (Fig. 17.3)
  - Techniques in line with the Brunkow concept (e.g., basic tension in accordance with Brunkow)
  - "Tetris" (FBL technique)
  - Stabilization exercises while standing with Vitality® band
  - 3D screw connection walking on stairs.
- Strengthening the scapulothoracic muscles.
- Isometric tension exercises in prone position, lateral position, supine position and standing (intensity: pain-free, low pain).
- Posture training.

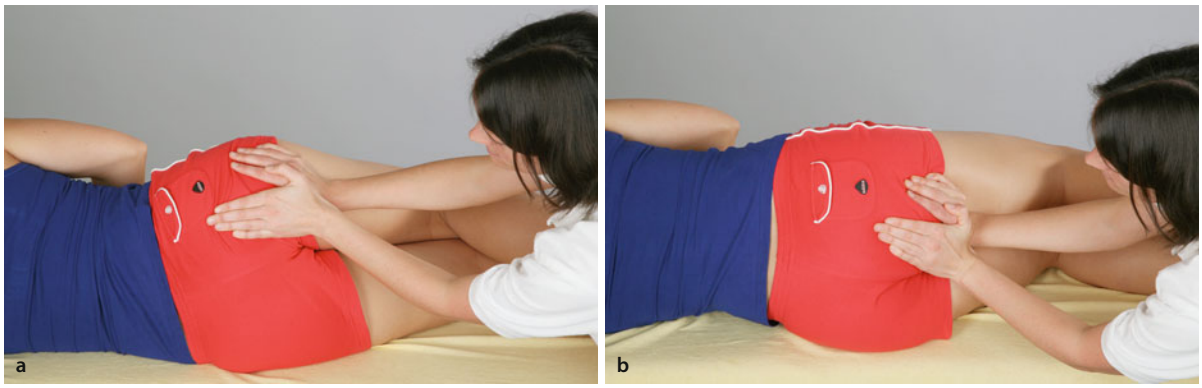

Fig. 17.3a,b Developing core stability through PNF pelvic pattern

Practical tip

Beginning segmental lumbar spine stabilization

- Abdominal hollowing test with the pressure feedback unit (PBU) to test the activity of the transverse abdominal muscle.
  - **Test structure:** starting in prone position with arms held by the sides, feet hanging over the edge of the bench. PBU lies under the stomach; the navel is located in the center of the PBU and the distal edge at SIAS level.
  - **Test run:** pump PBU at 70mmHg; the patient should then pull the lower abdomen inwards and upwards without moving the spine or the pelvis. Movement task: "Hold your lower abdomen flat."
    Hold tension for ten seconds while inhaling and exhaling; repeat ten times. Interpretation of the Paul Hodges test: the less the patient can reduce pressure, the worse the activity will be:
    <72mmHg: abnormal response
    72–74mmHg: average response
    >74/76mmHg: normal response.
- Activation of the pelvic floor muscles and transverse abdominal muscle using the Pressure Biofeedback Unit (PBU) (standing or supine position/quadrupedal/lateral position/prone position).

Physical measures

- Hot rolls.
- Manual lymph drainage.
- Electrotherapy (diadynamic current, LP 50/100Hz).

17.2 Phase II

Goals (in accordance with ICF)

Goals of phase II (in accordance with ICF)

- **Physiological function/bodily structure:**
  - **Improvement in segmental stability**
  - **Improving core stability/muscular corset**
  - **Improving physical perception**
  - **Improving sensorimotor function**
  - Improving muscular strength
  - Pain relief/management
  - Avoiding functional and structural damage
  - Improving mobility
  - Promoting resorption
  - Regulation of impaired vegetative and neuromuscular functions
- **Activities/participation:**
  - Performing change of position as needed for surgery
  - Correction of improper posture and movement pattern
  - Developing active coping strategies for dealing with pain
  - Hints and tips for self-sufficiency when meeting the challenges of daily routines
  - Learning a home training program
  - Promoting mobility (maintaining and changing body position, walking and movement with spine stabilized by the muscles)
  - Breaking down barriers that impede participation (anxiety)

17.2.1 Physiotherapy

Patient education

- Discussing the content and goals of treatment with the patient.
- Information regarding back-friendly behavior (back training) depending on the patient's participation in ADL activities.
- Ergonomic advice.
- Memory function for everyday life: creating own memory aids (e.g., by installing reminders).

Practical tip

Explanation so that the patient better understands the treatment:

- The following muscle groups are important components in the local stability of the spine and also involved in movements of the extremities: longus colli muscle, longus capitis muscle, rectus capitis anterior and lateralis muscles, transverse abdominal (TA) muscle, multifidus muscles and pelvic floor muscles
- Explaining the cervical neuromotor control of the cervical spine
- Location of the muscle groups, anatomical explanation
- Pain, rest, inflammation or trauma could lead to insufficient muscle coordination, an insufficient feed forward mechanism and quick fatigability of the cervical muscles in the event of cervical spine problems

Fig. 17.4 Treatment of hypertonic, shortened muscles: sternocleidomastoid muscle

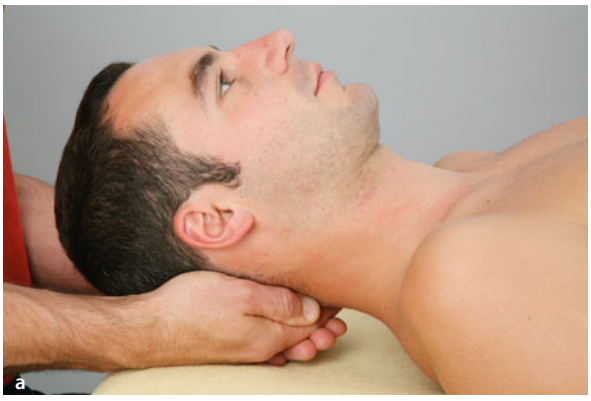

Fig. 17.5a,b Craniosacral therapy. **a** CV4 technique to normalize the craniosacral rhythm, **b** Mobilization of the atlantoaxial joint (**Cave:** continuous movement)

Treatment objectives

- Improving motor control/coordination of the deep and surface cervical flexors
- Improving the endurance of the deep cervical flexors (longus capitis muscle and longus colli muscle)
- Inhibition of the surface flexors of the sternocleidomastoid muscle, hyoideus muscle, scaleni muscles: these may not dominate
- Improving the eccentric muscle activity of the flexors
- Improving cervical extensors

Promoting resorption

- Manual lymph drainage.
- Breathing therapy – training diaphragmatic breathing.

Improving mobility

- Soft tissue treatment:
  - Treatment of hypertonic, shortened muscles: sternocleidomastoid muscle (Fig. 17.4), trapezius muscle, levator scapulae muscle, scaleni muscles, pectoralis major and minor muscles
  - Treatment of the fascia: neck fasciae and platysma relaxation technique.
- Mobility control of the thoracic spine/lumbar spine/pelvis/shoulder (potentially with manual therapeutic treatment).
- Mobilization of 1st to 5th ribs (costovertebral, sternocostal joint) and thoracic (1-5).
- Relaxing/detonizing the ligament structures: cervical pleura ligament.
- Correction of pelvic misalignment by resting on a mobilization wedge or manual therapeutic treatment.
- Craniosacral therapy:
  - CV4 technique to normalize the craniosacral rhythm (Fig. 17.5a). Effect: tone reduction in the connective tissue and sympathetic nervous system, improving venous discharge
  - Cervicothoracic diaphragm: unwinding technique: one of the therapist's hands is positioned at the level of the seventh cervical vertebra to second thoracic vertebra, with the other hand being placed across the upper rib cage
  - Mobilization of the atlantoaxial joint (**Cave:** Further movement) (Fig. 17.5)
- Decompensation of the lumbosacral transition.
- Sacrum techniques around the different axes depending on findings.
- Checking whether craniomandibular dysfunction (CMD) is present, i.e., checking the mandibular joint, the masseter muscle, the cranial bone, the lower jaw position when opening/closing the both as well as the surrounding structures.

Regulation of vegetative and neuromuscular functions

- Treatment in the orthosympathetic and parasympathetic areas of origin Th1–Th5 as well as OAA complex, e.g., oscillations, manual therapy, hot rolls.
- Treatment of neurolymphatic (NLR) and neurovascular reflex points (NVR):
  - Neck extensors and flexors, SCM
  - Trapezius muscle.

In case of chronic tension, overloading of the muscle chains must also be considered in terms of Brügger's sterno-symphyseal load-bearing.

- Treatment of possible tender points through strain-counterstrain technique: Apply pressure to the tender point in the muscle. Move the neighboring joints until the pain subsides or the tissue has noticeably relaxed. Hold the position for 90 seconds and then passively(!) return to the starting position.
- Treatment of potential trigger points with techniques in accordance with Simons/Travel or INIT:
  - INIT: Apply ischemic compression to the trigger point until the pain lessens. Should no change in the pain occur after 30 seconds, relieve compression and apply a positional release technique: convergence of the structures (caution: surgical area) until release, then seven seconds of isometric tension with subsequent stretching and application of ice – from the trigger point in the direction of the transition zones:
    Trapezius muscle
    Sternocleidomastoid muscle
    Levator scapulae muscle.

Improving sensorimotor function

- Perception of physiological spine position/posture training (mirror).

Improving depth perception and reducing pain

- Head positioning exercises in conjunction with laser pointer (fixation to the head): e.g., following a horizontal figure eight on the wall
- Head-eye coordination exercises
- Oculomotor exercises
- Training sense of joint position

The evaluation of kinesthesis is measured by the ability to return from a terminal pain-free movement to a neutral reference position chosen by the patient him/herself in advance without the need for visual or vestibular aids. Any deviation from this which might arise

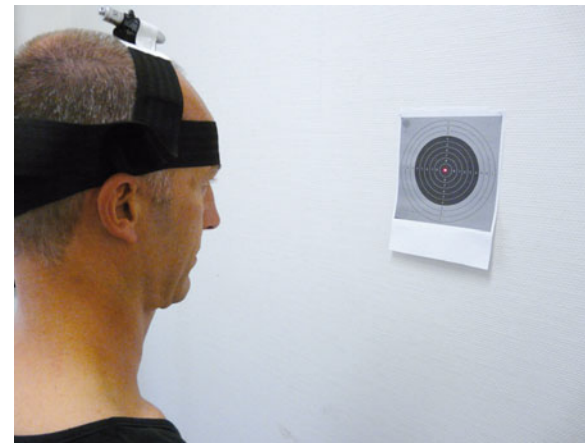

Fig. 17.6 Determining the JPE using a laser pointer

is referred to as JPE (joint position error) and is measured using a laser attached to the head.
The JPE is determined as follows:

- Structure: target is located at eye-level on the wall.
- Starting position: patient sitting. The thighs are at their lowest possible contact surface and the arms hang more loosely below (minimum tactile input). A laser pointer is on the head (Fig. 17.6).
  1. Adopt neutral neck position
  2. Awareness of position with starting point in the middle
  3. Eyes closed and perceive position again
  4. Extension/rotation up to approx. 30° (pain-free limit) with closed eyes
  5. Patient should return as close as possible to the start point and hold position (normal, daily speed)

Assessment: deviation of more than 3°-4° or a jerky cervical spine movement may be an indication of the impaired perception of joint position.

- Exercises to train sense of movement/joint position:
  - Starting in seated position. Returning to a prearranged head position following active cervical spine movements in flexion, extension, lateral flexion and rotation. The laser is used to assist in orientation.
    First with open and then with closed eyes:
    Flexion as far as possible, extension as far as possible, and then return as close as possible to the starting position, extension as far as possible, flexion as far as possible, then ultimately return as close as possible to the starting position, with lateral flexion and rotation

- Potential sequence of exercises, tracking with the laser: follow straight, diagonal and elliptical lines Figure eight
- Progression for all points: increase speed and range of motion, duration of exercise, change visual target (background), change starting position (sitting, standing, standing on one leg...)

- Exercises for sight stability:
  - Vision remains fixed (eyes fixed on a single point) – head moves:
    Supine position: mobilization of the head with gaze fixed on one point
    Headquarters: gaze remains stably focused on a point and the head moves, e.g., in rotation
  - The eyes focus on a target, while the core rotates or flexes laterally
  - As independent exercise for eye-arm-head coordination: Fold the hands and bring the arms to shoulder height while extended. Fix eyes on the thumbs and rotate left and right/bend laterally/extend and flex the head, while keeping the gaze fixed stably on the thumbs.
- Breathing awareness (diaphragm, abdominal respiration).
- Traction and sliding stimuli via contact on the cervical vertebrae. Starting in supine or seated position
  - Patient should hold position statically against the therapist applying pressure to the neural arch
  - Patient actively follows the movement of the therapist's guided contact.
- Sensorimotor function training on balancing/seesaw board.
- Balancing a book or beanbag on the head; while sitting (Fig. 17.7), standing, walking.
- Ideokinesis: Increasing physical and movement sensitivity with the help of visual representations.

Stabilization and strengthening

- Segmental stabilization in various starting positions, beginning in supine position (see also lumbar spine, ▶ Section 19.2.1).

Craniocervical flexion test (CCF)

Segmental stabilization of the cervical spine via the deep cervical musculature:

- Longus colli muscle
- Longus capitis muscle
- Rectus capitis anterior and lateralis muscles = deep neck flexors
- Semispinalis cervicis muscle
- Multifidus muscles

Fig. 17.7 Balancing a book on the head while sitting to activate the muscles

Test run

Patient position:

- Supine position
- Cervical spine in neutral position
- Tongue lies relaxed on the roof of the mouth
- Pressure biofeedback unit (PBU) sub-occipitally or palpation on the neck. Hand position: right hand on occiput, fingers of the left hand on the cervical spine lordosis; thumbs of the left hand palpates the splenius cervicis muscle/sternocleidomastoid muscle (Fig. 17.8)
- Forced diaphragmatic breathing from text run

Movement

- In order to rule out over-activity in the upper trapezius muscle and levator scapulae muscle, first move the shoulder blades dorsally and caudally
- Performing upper cervical flexion movement – pump "nodding" pressure sensor at 20mmHg, patient should increase pressure on the sensor, hold position for ten seconds, move slowly and in a controlled way, without major exertion
- No compensation mechanism → then increase by 2mmHg

Interpretation

- Correct activation leads to flattening of the cervical spine lordosis
- Increase in pressure is displayed
- Increase pressure by only 2mm from 20 to 22mmHg; increase in 2mmHg intervals up to 30mmHg
- Hand palpation: when performed correctly, the pressure raises to the left hand

Compensation

- Hyperactivity of the sternocleidomastoid muscle: retraction of the head
- Hyperactivity of the extensors (occiput weight increases)
- Over-activity of the supra/infrahyoidal muscles (jaw should be relaxed)

Fig. 17.8 **a** Craniocervical flexion test (CCF): Pressure biofeedback unit (PBU) sub-occipitally, **b** With palpation on the neck. Hand insertion: right hand on occiput, fingers of the left hand on the cervical spine lordosis; thumbs of the left hand palpates splenius cervicis/sternocleidomastoid muscle

- Improving endurance by holding individual levels of pressure for ten seconds (target: 10 × 10 secs).
- Isometric tension exercises in prone position, lateral position, supine position or sitting (intensity: pain-free, low pain), also in conjunction with tongue and eye movements.
- Isometric extension against elastic resistance: upper body extends while keeping a neutral cervical spine position (Fig. 17.9).
- Stabilization of the thoracic spine/lumbar spine.
- Training correct upright posture.
- Strengthening the shoulder-arm and scapulothoracic muscles while keeping the cervical spine stable.
- Stabilization exercises while standing in conjunction with Vitality® band or cable pulley.
- Symmetric and reciprocally asymmetric resistance combinations via shoulder blade and pelvis.
- Hold Pezzi ball against the wall with the occiput while standing. (Lower cervical spine in neutral position).
- Exercising movement transitions with muscular stabilization.
- Training the deep neck flexors:
  - While sitting against the wall (Fig. 17.10)
  - Free sitting/standing under segmental stabilization of the lumbar spine.
- Integration training for everyday life/workplace (functional and ergonomic).
- Redcord®: starting in supine position (Fig. 17.11) or standing.
- Pilates: Head Nod, Cervical 8.
- Exercises with axial compression: squats, lats.
- Isometric exercises in extension and flexion position.
- Walking on the treadmill.
- Automobilization of the spine segments under cervical spine stability.
- Therapeutic climbing.
- Improving foot stability.

All exercises must be performed in such a way that the segmental stabilization of the cervical spine and lumbar spine is considered.

Physical measures

- Foot reflexology massage:
  - Drink sufficient water, don't forget balancing grips
  - Treatment of symptom zones and vegetative zones.
- Acupuncture massage (APM).
- Lymph drainage (note: swelling in the supraclavicular space).

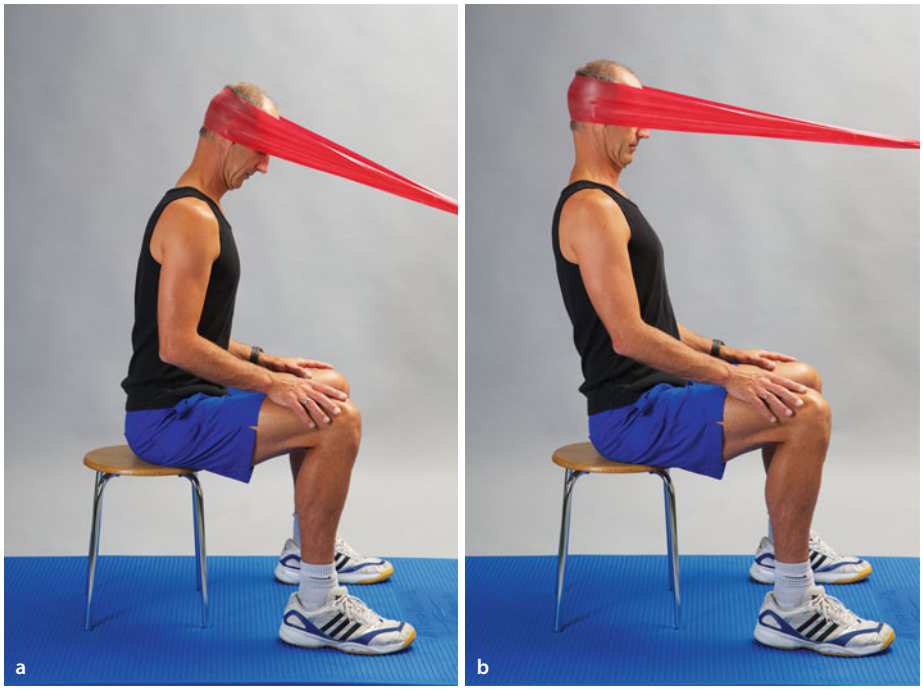

Fig. 17.9a,b Isometric extension against elastic resistance: upper body extends while keeping a neutral cervical spine position

Fig. 17.10 Training the deep neck flexors while sitting against the wall

Fig. 17.11 Redcord®: starting in supine position

- Massage.
- Electrotherapy (depressant current).
- Extensive connective tissue massage in the shoulder-neck region.
- Hot rolls.

Practical tips

- Go to vertical as soon as possible!
- Low intensity in all stabilization exercises to prevent general muscle activation
- Local stability: feed-forward training: low tonic innervation, proprioceptive input
- Sitting with stabilizing basic tension
- Integrate breaks and physical perception training regularly into the daily routine (plan in breaks lying down)
- Walking
- Back training program (practice and theory)
- Potentially consult a dentist due to the effect of biting and teeth problems

17.2.2 Medical training therapy

- General accompanying training of the cardiovascular system:
  - Ergometer training 1 × 10 up to 2 × 15 mins with low load at 20–50W
  - Treadmill exercise as walking training with slight incline
  - Crosstrainer/elliptical training 1 × 10 up to 2 × 15 mins with low load at 20–50W
  - Orthopedic walking.

Sensorimotor function training

Transition from conscious to unconscious movement control.

- Segmental stabilization.
- Depth position (perceiving the joint position of the cervical spine).
- Physical perception training regarding position and movement of the lumbar spine and the pelvis:
  - Feldenkrais, Tai Chi.

Strength training

- Intramuscular activation via isometry (Fig. 17.12).
- Strength endurance training, adjusted to plans; focus on local stabilizers; 4 × 20(-50) repetitions within absolutely pain-free range.
- Isometric activation through long holding times with low intensity (20–30% with holding time of over one minute).
- Overflow via movement of extremities with stabilized cervical spine (segmental stabilization):
  - Bench presses
  - Rowing
  - Dips
  - Cable pulley
  - Vitality® band: PNF arm diagonal patterns.
- Mono-directional training from stable starting positions: sitting on fitness equipment; only work one side and with a low weight (Fig. 17.13).
- Intensification/rhythmization through breathing.

Therapeutic climbing

- Weight transferring training on middle handles while standing (Fig. 17.14).
- Step alternating training on large steps with stable grip fixation.

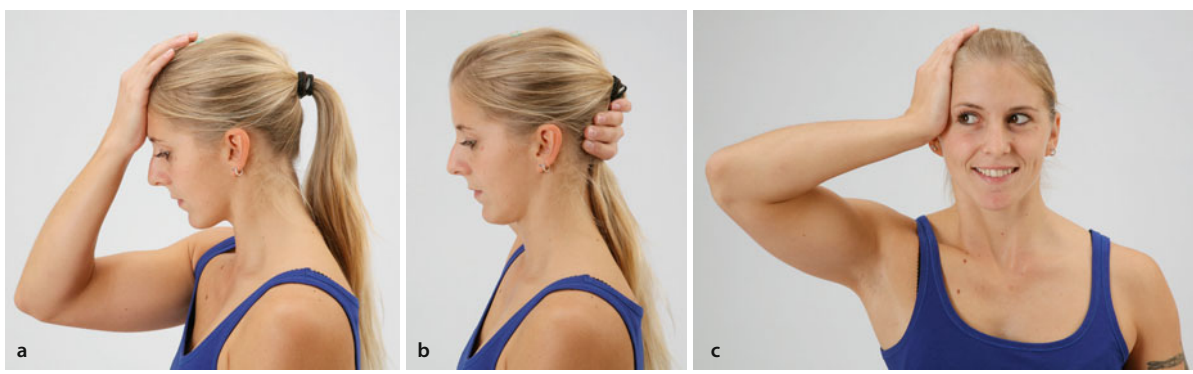

Fig. 17.12a–c Intramuscular activation via isometric tensing of muscles

Fig. 17.13a,b Mono-directional training from stable starting positions: Sitting on fitness equipment; only work one side and with a low weight

Fig. 17.14 Therapeutic climbing: load changing training on middle handles while standing

17.3 Phase III

Goals (in accordance with ICF)

Goals of phase III (in accordance with ICF)

- **Physiological function/bodily structure:**
  - **Improving physical perception**
  - **Restoration of segmental stability**
  - **Optimization of core stability/muscular corset**
  - **Improving mobility**
  - Improving sensorimotor function
  - Improving muscular strength
  - Pain relief/management
  - Improving physiological movement pattern
- **Activities/participation:**
  - Correcting posture (developing ergonomic posture/working posture)
  - Developing active coping strategies for dealing with pain
  - Hints and tips for self-sufficiency when meeting the challenges of daily routines
  - Learning a home training program
  - Promoting mobility (maintaining and changing body position, walking and movement with spine stabilized by the muscles)
  - Breaking down barriers that impede participation (anxiety)
  - Rehabilitation into work, sport
  - Ergonomic advice for everyday and working life

Fig. 17.15a,b Soft tissue treatment. **a** Suprahyoidal muscles, **b** Superficial and deep neck fasciae

17.3.1 Physiotherapy

Patient education

- Discussing the content and goals of treatment with the patient.
- Ergonomic advice for everyday life and for work: e.g., chairs, computer position; sport: e.g., handlebar position when cycling.
- Reducing anxiety further/motivation to undertake physical activity.
- Training head posture and movement while driving or other everyday activities.

Improving mobility

- Mobilization of the cervicothoracic transition, the rib joints and thoracic spine depending on findings.
- Techniques from craniosacral therapy: occipital lift, cranial-base release, unwinding for craniocervical diaphragm.
- Improving pelvic tilt by learning physiological midposition.
- Mobilization of neural structures: slump, ULNT 1–3.
- Segmental mobilization (**Cave:** proceeding carefully in the direction of the segments that underwent surgery, not in the case of spondylodesis).
- Soft tissue treatment:
  - Treatment of the surrounding muscles: sternocleidomastoid muscle, mouth base, scaleni muscles, levator scapulae muscle, trapezius muscle, suprahyoid muscles (Fig. 17.15a), Suboccipital muscles.
  - Treatment of the fascia: superficial and deep neck fasciae (Fig. 17.15b)
  - Treating ligaments: cervical pleura ligaments.

Correlations with the following structures arise via the inserting muscles on the hyoid bone: lower jaw, temporal bone, pharynx, shoulder blade, breastbone, collarbone and tongue.

Fig. 17.16 Visceral mobilization

Monitoring cranio-mandibular function due to the influence on the cervical spine. Example: increasing the tone of the masseter and temporal muscles. This leads to a high degree of cervical extension. This results in a higher input on the trigeminocervical nucleus through afferent nerve pathways from the craniomandibular and craniocervical region.

- Mobility control of the lumbar spine, thoracic spine (potentially with manual therapeutic treatment).
- Controlling pelvic position and lower extremity.
- Visceral mobilization depending on findings, e.g., diaphragm, mediastinum, liver, stomach and spleen fasciae (Fig. 17.16).
- Mobilization under compression.

Fig. 17.17 Coordination and balance training with Bodyblade

Regulation of vegetative and neuromuscular functions

- Treatment of OAA complex (occiput-atlas-axis) as well as Th1-Th5 and ribs 1-5.
- Treatment of neurolymphatic and neurovascular reflex points: neck extensors and flexors.

Improving sensorimotor function

- Beginning coordination and balance training with small equipment
  - Body blade (Fig. 17.17)
  - Gyrotonic.
- Training on unstable surfaces (balance pad, MFT, balance board, Pezzi ball, platform etc.).

Stabilization

- Increasing segmental stabilization; all starting positions with segmental cervical spine stability:
  - Transition to everyday loads
  - Posture training/support functions
  - Knee-bends/interval training/climbing stairs
  - Progression by lengthening the lever/dynamization (Fig. 17.18)
  - Initial rotation variants
  - Gait training.
- Training the deep neck flexors moving from extension to flexion, starting in seated position to supine position in overhang:

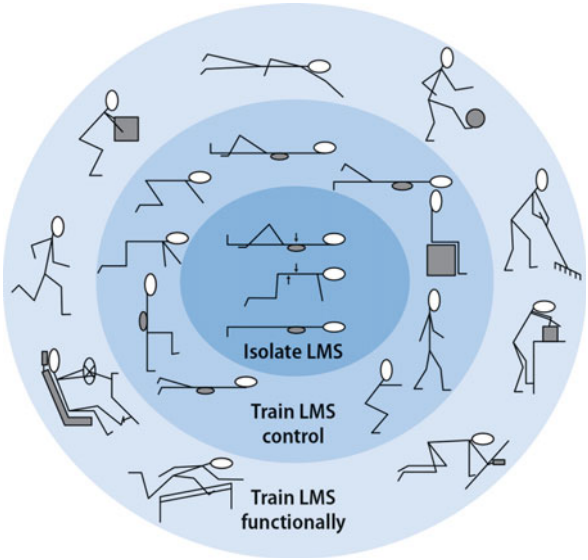

Fig. 17.18 Model for the progression of stabilization exercises. (According to Twomey and Taylor 2000, courtesy of Elsevier)

  - Raising when standing: head supported on the ball (Fig. 17.19).
- Chopping and lifting on the cable pulley in half kneeling position or one-legged kneeling (hips in neutral position and controlled core).
- Concentric extension and eccentric control with flexion movement: starting in forearm plank, standing in front of the bench or quadrupedal position:

Fig. 17.19 Training the deep neck flexors moving from extension to flexion, raising while standing: Head supported on the ball

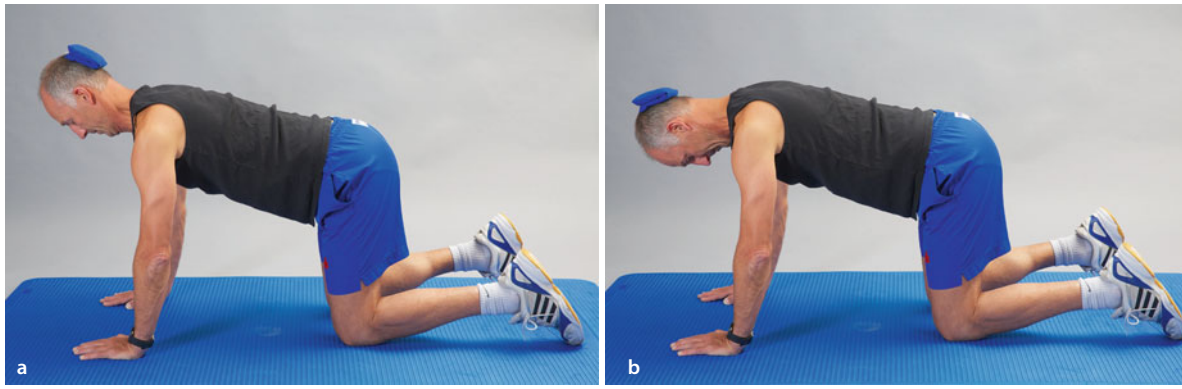

Fig. 17.20 **a** Concentric extension and **b** Eccentric controls with flexion movement

upper cervical flexion should be held. More advanced option with small weight (small beanbag or similar) on the head (Fig. 17.20)
- Isometric cervical spine extension against a weight sling or against Vitality® band
  - With dynamic arm extension against cable pulley while standing
  - With horizontal abduction in the shoulder joint.
- Resistance training with free weights
- Training the neck extensors in prone position: lumbar spine segmental stabilization, shoulder blade in retraction:
  - Raising head
  - More advanced option using weight bands or Vitality® band.
- Rhythmic stabilization in various starting positions. Making more advanced through short, rapid movements to exert constantly different stimulus on the muscles of the back.
- Beginning with muscle building training and initiating rotation while standing with traction device or dumbbells (unilateral) (Fig. 17.21).
- Exercises from prone position without weights, e.g., "swimming".
- Everyday activities: movement transitions with segmental stabilization (lifting and bending training).

All exercises must be performed under the segmental stabilization of the cervical spine.

Physical measures

- Traditional massage in thoracic spine and shoulder-neck area.
- Marnitz key zone therapy.
- Application of heat (potentially ventrally in line with Brügger's theories).
- Acupuncture massage (APM).
- Foot reflexology massage.

17.3.2 Medical training therapy

- General accompanying training of the cardiovascular system:
  - Ergometer training: 20 mins with low load at 50–75W
  - Treadmill exercise as walking training (3–4km/hour) with slight incline (5–10%)
  - Elliptic/cross trainer: 20 mins with low load at approx. 75W
  - Orthopedic walking.

Fig. 17.21 Muscle building training and initiating rotation while standing with dumbbells (unilateral)

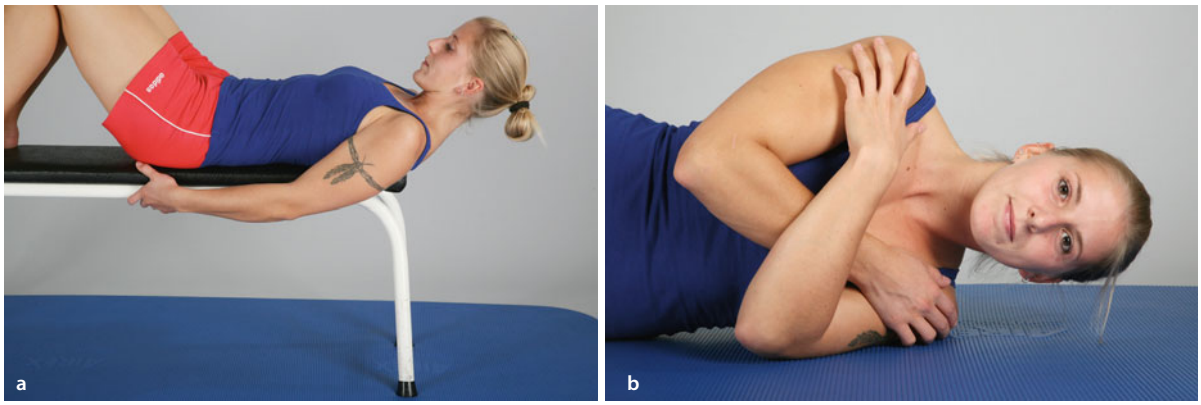

Fig. 17.22a,b Segmental stabilization **a** In supine position, **b** In lateral position

Sensorimotor function training

- Segmental stabilization in various positions: supine position (Fig. 17.22a), lateral position (Fig. 17.22b), standing, kneeling.
- Activation of mobilization of the cervical spine in low range of motion.
- Slow controlled transfer of weight:
  - Diagonal arm/leg pattern with stabilized lumbar spine/cervical spine (Fig. 17.23)
- Initiating feed forward deliberately:
  - Taking/passing small weights from different positions with eye contact.
- Physical perception training regarding position and movement of the cervical spine/lumbar spine and the pelvis (Fig. 17.24).

Strength training

- Intramuscular activation via isometry.
- Strength endurance training, adjusted to plans; focus on local stabilizers: 4× 20 (–50) repetitions within the completely pain-free range.
- Isometric activation through long holding times with low intensity in Redcord® (20-30% with holding time of over one minute) (Fig. 17.25).
- Overflow of movements of the extremities under controlled cervical spine movement (segmental control) using the cable pulley, Vitality® band (Fig. 17.26a) or dumbbells (Fig. 17.26b,c).
- Multi-directional training from variable starting positions, e.g., gyrotonic (Fig. 17.27)
- Intensification/rhythmization through breathing.

Fig. 17.23 Slow controlled transfer of weight: diagonal arm/leg pattern with stabilized lumbar spine/cervical spine

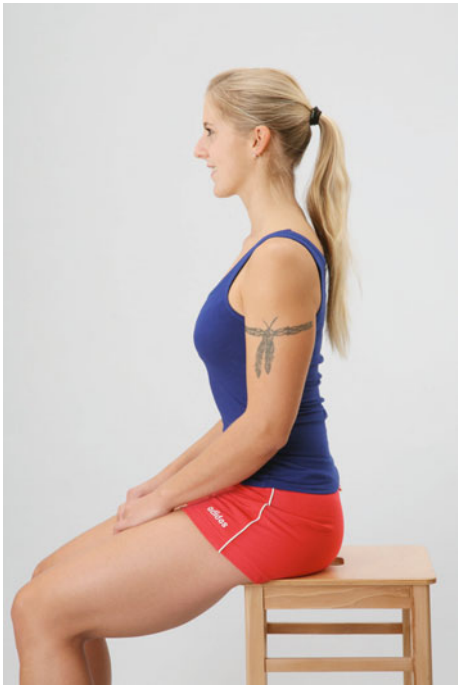

Fig. 17.24 Physical perception training regarding position and movement of the cervical spine/lumbar spine and the pelvis

Fig. 17.25 Isometric activation through long holding times with low intensity in Redcord® (20-30% with holding time of over one minute)

Fig. 17.27 Multi-directional training from variable starting positions: gyrotonic

Therapeutic climbing

- Step alternating training in the positive wall area, changing moves (up/down, side to side).
- Weight transferring training on middle handles in vertical wall area.
- Approval of rotational hand movements.

All hand movements are anticipated by sight!

17.4 Phase IV

The objective of training in phase IV lies in the patient's ability to resume sporting activities. The sports-therapeutic content of rehabilitation phase IV following operations on the cervical spine is summarized for the entire spine in ▶ Section 19.4.

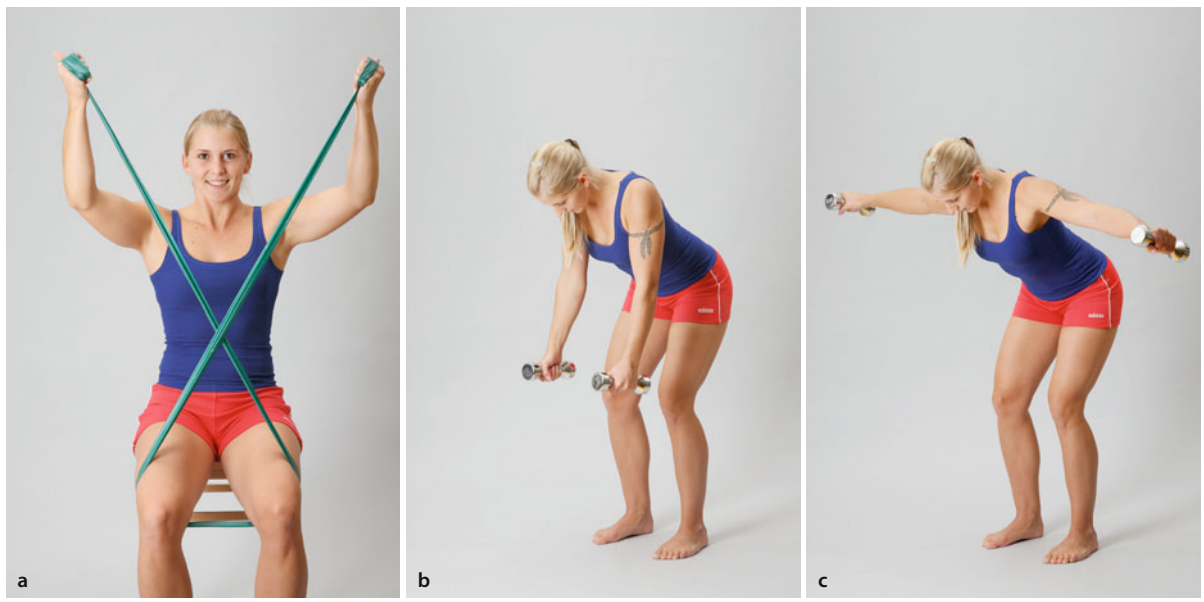

Fig. 17.26a–c Overflow over movements of the extremities under controlled cervical spine movement (segmental control) using an **a** Vitality® band and **b,c** Dumbbells

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Thoracic/lumbar spine: Surgical procedure/aftercare

Andreas Imhoff, Knut Beitzel, Knut Stamer, Elke Klein

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18.1 Fracture surgery

18.1.1 Kyphoplasty (Kyphon)

Indication

- Pathological spinal fracture without the involvement of the rear edge and without more severe axial defects.

Surgical method

- Prone position on X-ray capable table.
- Roll below thorax and pelvis (repositioning).
- Radiological localization of the affected segment(s) (C-arc).
- Percutaneous cannulation with Jamshidi needle into the vertebrae.
- Inserting the balloon catheter into the vertebral body up to 4mm before the ventral cortical bone (transpedicular possible bilaterally).
- Balloon dilation of the affected spine (max. 300 psi).
- Low-viscosity bone cement application in the cavity that arises (Fig. 18.1).
- X-ray examinations to prevent cement leakage.
- Wound closure layer by layer.

Aftercare

Table 18.1 provides an overview of aftercare.

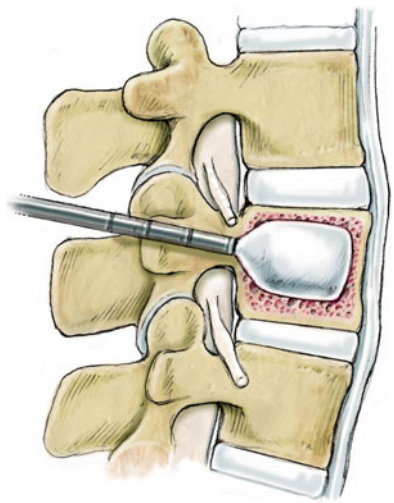

Fig. 18.1 Kyphoplasty

18.2 Intervertebral disc surgery

18.2.1 Lumbar microdiscotomy

Indication

- Secured prolapse with clear radicle symptoms.
- Acute cauda-conus syndrome.

Surgical method

- Holding the patient in knee squat position.
- Precise localization of the segment through image processing and cannula.
- Approx. 3cm long incision from a dorsal perspective.
- Incision of the thoracocolumbar fasciae and columns craniocaudally.
- Detaching the multifidus muscles from the interspinous ligament and the surrounding spinous processes.
- Depicting the interarcuate foramen and flavum ligament.
- Introducing the speculum to the yellow ligament and attaching it.
- Inserting the surgical microscope and continuing the operation using a microsurgical technique.
- Preparation of the yellow ligament into the epidural space.
- Potentially performing a hemilaminectomy.
- Medializing the dural sac and securing the retraction using hooks.
- Resection of potentially free intervertebral disc segments and extraction of the sequester with prolapse tongs.
- Closing the wound layer by layer once the fasciae have been sealed.

Aftercare

Table 18.2 provides an overview of aftercare.

Table 18.1 Kyphoplasty (Kyphon). So specific orthotics necessary

Phase	Range of motion and permitted load	
	from 1st day post-op:	No bracing necessary Core-stabilizing knee joint Mobilization depending on pain situation, while strictly observing the fundamental principles of back training

Table 18.2 Lumbar microdiscotomy. Lumbar stabilization orthosis (e.g. medi™ Lumbamed disc) for three months

Phase	Range of motion and permitted load	
I	from 1st day post-op:	Mobilization depending on pain situation, while strictly observing the fundamental principles of back training
II	from 12 weeks post-op:	Cycling, start of running training
III		
IV	From six months post-op:	Sport-specific training

18.3 Stabilization

18.3.1 Spondylodesis dorsally

Indication

- Instability through laminectomy (bilaterally or multiple stages).
- Symptomatic spondylolisthesis.
- Degenerative scoliosis.

Surgical method

- Radiological localization of the affected segment(s).
- Strictly central longitudinal incision via the spinal segment concerned.
- Shifting the back extensor muscles from the spinous processes to the vertebral arches.
- Exposing the spinous processes, lamine and vertebral joints.
- Anchoring the spondylodesis screw through the vertebral arch concerned into the vertebrae bilaterally.
- Careful exposure of the spinal section with outgoing nerve routes through laminectomy of the affected segments in the case of spinal narrowing.
- Connecting the screws of the respective side through longitudinal support wires. Insertion of bone around the longitudinal support wires for the later fusion and bony integration of the spondylodesis (Fig. 18.2).
- Wound closure layer by layer.

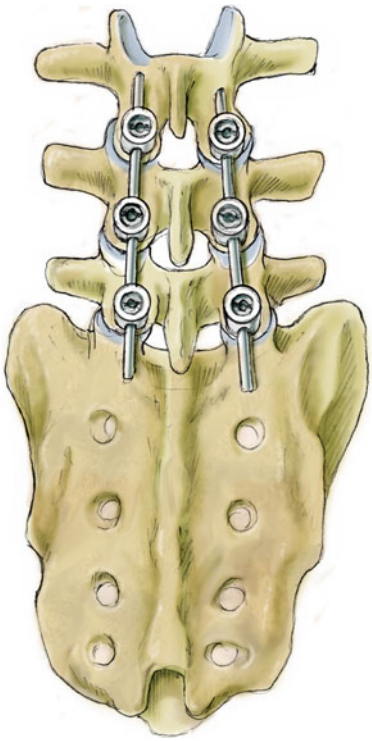

Fig. 18.2 Dorsal spondylodesis of lumbar vertebral bodies 3–5

Aftercare

Table 18.3 provides an overview of aftercare.

Table 18.3 Spondylodesis dorsally. Chairback brace for 12 weeks post-op

Phase	Range of motion and permitted load	
	from 1st day post-op:	"En bloc" rotation allowed. Standing in front of the bed, then slow mobilization with Chairback brace. (No deep sitting for six weeks post-op in the case of spondylodesis of the lumbar spine)
	from 12 weeks post-op:	Following consolidation of the spondylodesis, wean off Chairback brace. Increasingly free mobilization

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Thoracic/lumbar spine: Rehabilitation

Andreas B. Imhoff, Knut Beitzel, Knut Stamer, Elke Klein

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19.1 Phase I

Phase I of rehabilitation following thoracic/lumbar spine surgery corresponds to phase I following cervical spine surgery (▶ Section 17.1).

19.2 Phase II

Goals (in accordance with ICF)

Goals of phase II (in accordance with ICF)

- **Physiological function/bodily structure:**
  - **Improvement in segmental stability**
  - **Improving core stability/muscular corset**
  - **Improving physical perception**
  - Improving sensorimotor function
  - Improving muscular strength
  - Pain relief/management
  - Avoiding functional and structural damage
  - Improving mobility
  - Promoting resorption
  - Regulation of impaired vegetative and neuromuscular functions
- **Activities/participation:**
  - Learning change of position as needed for surgery
  - Correction of improper posture and movement pattern
  - Developing active coping strategies for dealing with pain
  - Hints and tips for independence when meeting the challenges of daily routines
  - Learning a home training program
  - Promoting mobility (maintaining and changing body position, walking and movement with spine stabilized by the muscles)
  - Breaking down barriers that impede participation (anxiety)

19.2.1 Physiotherapy

Patient education

- Discussing the content and goals of treatment with the patient.
- Explaining current stage of wound healing and the associated restrictions (load bearing capacity and movement) in order to build trust in the allowed movement.
- Information regarding back-friendly behavior (back training) depending on the patient's participation in ADL activities
  - No long lever, e.g., above lifting the legs
  - No vertical bending
  - "En bloc" rotation
  - Changing position and movement transitions via controlled, conscious muscular tension
  - No sitting for extended periods.
- Ergonomic advice.
- Memory function for everyday life: creating own memory aids (e.g., by installing reminders).
- In the case of **spondylodesis**, the hip joint flexion is somewhat dependent upon the height of the fusion being restricted to 45° (lower lumbar spine) or 90° for six weeks (consultation with surgeon), and only elevated sitting is therefore permitted.

Practical tip

Explanation so that the patient better understands the treatment:

- The following muscle groups are important components in the local stability of the spine and also involved in movements of the extremities: transverse abdominal muscle (TA), multifidus muscles (MF), pelvic floor muscles and diaphragm
- Synergy between adductors, pelvic floor muscles and transverse abdominal muscle
- Location of the muscle groups; anatomical explanation
- Poor activation in the case of lumbar spine problems (pain, preservation, intervertebral disc problems, post-op and conservative)

Treatment objectives

- Voluntary and automatic co-activation MF/TA– involvement of both muscle groups under co-activation of the diaphragm and pelvic floor
- Transverse abdominal muscle + pelvic floor tension (while simultaneously tensing the hamstring group and the gluteal muscles, otherwise this triggers the automobilization of the lumbar spine)
- Initiation + coordination + endurance = activation of both muscle groups and making training more advanced by increasing the load (lengthening the lever)

Promoting resorption

- Depending on findings (see phase I, ▶ Section 17.1.1).

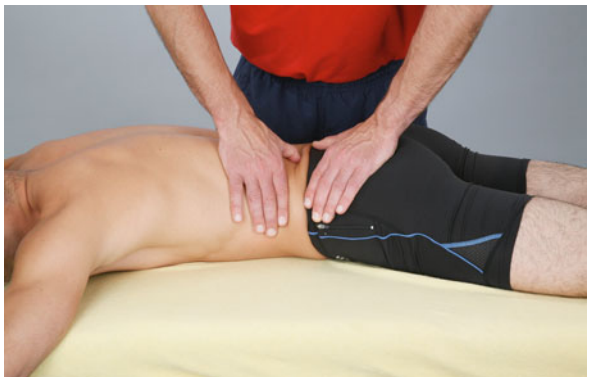

Fig. 19.1 Treatment of the fascia: thoracolumbar fascia

Improving mobility

- Soft tissue treatment:
  - Treatment of the surrounding muscles: piriformis muscle, psoas muscle, iliac muscle, quadratus lumborum muscle, pelvic floor muscles, tensor fasciae latae muscle
  - Mobilization of the ligaments: sacrotuberous ligament, sacrospinal ligament, iliolumbar ligament
  - Treatment of the fascia: thoracolumbar fascia (Fig. 19.1)
  - Transverse extension in gluteal area.
- Sacrum techniques: mobilization around the various sacral axes: extension, flexion, tilting sideways. **Cave:** Surgical area (L5/S1)!

Sensitive treatment is important, as significant vegetative and emotional responses may be triggered.

- Mobility control of the cervical spine, sacroiliac joint, hip joint (potentially with manual therapeutic treatment).
- Mobilization of the foot.
- Controlling the cause-effect chain (examples see ▶ Section 15.3.1.
- Correction of pelvic misalignment by resting on a mobilization wedge or manual therapeutic treatment.
- Craniosacral therapy:
  - Decompensation of the lumbosacral transition
  - Treatment of the pelvic floor: Influence on the position of the sacrum, coccyx, pubic bone (abdominal muscles), hip joint (pelvic trochanter muscles), organs of the lesser pelvis.
- Improving the gliding ability of neural structures by working carefully with slider or tensioner techniques to reduce scar adhesions
  - Mobilization caudally: starting in lateral position: lumbar spine supported and leg rested on block; hip flexion at 70° to prevent the further movement of the lumbar spine (**Cave:** Watch out for shortening of the ischiocrural muscles); upper ankle joint in maximum dorsal extension; mobilization via flexion/extension of the knee joint
  - Mobilization cranially: starting in lateral position: lumbar spine supported; legs stretched; mobilization through flexion of the thoracic spine and cervical spine.

Regulation of vegetative and neuromuscular functions

- Treatment in the orthosympathetic and parasympathetic areas of origin C8–L2 as well as S2-S4, OAA complex: manual therapy, hot rolls.
- Treatment of neurolymphatic (NLR) and neurovascular points (NVP):
  - Gluteus maximus, medius and minimus muscles
  - Iliopsoas muscle.
- Treatment of potential trigger points with techniques in accordance with Simons/Travel or INIT:
  - Gluteus medius and minimus muscles
  - Longissimus thoracis muscle
  - Quadratus lumborum muscle.
- Careful vibrations in anterior position from prone position in the segments above or below.
- Extensive connective tissue massage.
- Treatment of the symphysis in the case of Brügger's sterno-symphyseal syndrome and adductor crossing – abdominal muscles.

Orthosympathetic and parasympathetic relationships to the axial system and organs

- **Vertebrae C0–C2/OAA**
  Valgus (parasympathetic) superior cervical ganglion (orthosympathetic)
  - Head/neck organs (parasympathetic and orthosympathetic)
  - Heart, lungs, thymus gland, osophagus, liver, gall bladder, stomach, spleen, pancreas, duodenum, small intestine, caecum, ascending and transversum colon, kidneys, adrenal gland, upper 1/3 of the ureter (para-)
- **Vertebrae C6-C7**
  Middle cervical ganglion (orthosympathetic)
  - Heart, lungs, osophagus, liver, gall bladder, stomach, spleen, pancreas, duodenum
- **Vertebrae Th1-Th5/ribs 1-5**
  Stellate ganglion (orthosympathetic), sympathetic trunk (orthosympathetic) cardiac plexus (orthosympathetic)
  - Head/neck organs, heart, lungs, thymus gland, esophagus

- **Vertebrae Th6-Th9/ribs 6-9**
  Celiac ganglion (orthosympathetic), sympathetic trunk (orthosympathetic)
  – Liver, gall bladder, stomach, spleen, pancreas, duodenum
- **Vertebrae Th10-Th11/ribs 10-11**
  Superior mesenteric ganglion (orthosympathetic), sympathetic trunk (orthosympathetic)
  – Small intestine, caecum
- **Vertebrae Th12–L2/rib 12**
  Inferior mesenteric ganglion (orthosympathetic), sympathetic trunk (orthosympathetic)
  – Ascending colon, transverse colon, descending colon, sigmoid, adrenal glands, kidneys, urethra, pelvic organs, genitals
- **S2–S4/Sacrum**
  Sacral plexus (parasympathetic)
  – Descending colon, sigmoid, pelvic organs, genitals, lower 2/3 of the urethra
- **Coccyx**
  Ganglion impar (orthosympathetic)
  – Pelvic organs.

Fig. 19.2 Sensorimotor function training on balancing/seesaw board

Improving sensorimotor function

- Perception of physiological spine position (mirror).
- Breathing awareness (diaphragm, abdominal respiration).
- Sensorimotor function training on balancing/seesaw board (Fig. 19.2).

Stabilization and strengthening

- Segmental stabilization in various starting positions (see following overview).

Segmental stabilization

Use of a pressure biofeedback unit (PBU)

Transverse abdominal muscle

- Starting in supine position
- Explain position and have patient "relax abdominal wall completely"
- Begin by perceiving abdominal respiration
- Palpation (tactile initiation), transverse abdominal muscle 1-2cm medially to the anterior superior iliac spine – by therapist or patient (Fig. 19.3a)

Fig. 19.3a,b Segmental stabilization. **a** Transverse abdominal muscle: Palpation 1-2cm medially to the anterior superior iliac spine by the patient, **b** Multifidus muscles: tactile stimulus on the transverse processes or laterally between the spinous processes deeply, support with middle and index finger (slightly tilted position). The patient should develop tension paravertebrally/symmetrically against the gentle pressure

- **Tips** for potentially addressing the patient:
  - "Draw the abdominal wall below the navel in slightly"
  - "Hold your lower abdomen flat"
  - "Contract anterior superior iliac spine by 1mm"
  - "Pull belt tighter"

Multifidus muscles

- Starting position prone position
- Explanatory model for the building of tension: The vertebral bodies represent three blocks lying on top of each other, with the middle block being pulled 1mm ventrally
- Tactile stimulus on the transverse processes (Fig. 19.3b) or laterally between the spinous processes deeply, support with middle and index finger (slightly tilted position). The patient should develop tension paravertebrally/symmetrically against the gentle pressure
- Begin outside of the surgical, scar or discomfort area, then slowly work towards the problem area

Pelvic floor muscles

- Perception via palpation and coughing
- Tensing pelvic floor
  - **Tips** for possible ways to phrase things for the patient:
    "Riding an elevator"
    "Holding in urine"
- Then vary starting positions: supine/lateral/prone position/standing/quadrupedal position = become vertical as quickly as possible!
- Homework: tense slightly 10 x 10 seconds/in various positions under everyday stresses (ADL and transfer)
- The tensing should be gentle, slow and at a low intensity
- Regardless of breathing – when exhaling, segmental stabilization must be held!
- Tactile assistance: one hand above and one hand below the navel (patient or therapist)
- Tension in stages (100%/50%/20%)
  Constantly keep 20% tension as a basis!

Exercise variations

- Variation of lateral position:
  - At first, support for the waist triangle
  - The patient should later be able to compensate for the waist gap in a coordinated manner – straight spine!
  - Specifically for segment L5/S1: Imagine pulling the thigh along the longitudinal axis in the direction of the acetabulum
  - Should no tension be possible in isolation (poor physical perception, cognitive impairments), work from **proximal** to **distal** through rotation resistance.

Expanding upon the potential variants when mastering activation

- Variation of supine position:
  - Increase basic tension from 20%
  - Controlling tension, use of PBU
  - Bring legs towards each other in 90/90° position and back again
  - Slowly stretching a leg from 90° flexion to 0° extension
  - Number of repetitions is determined by the duration of correct basic tension.
- Variation of quadrupedal position:
  - Basic tension (20% muscle tension)
  - Controlling local stability
  - Variations/degrees of difficulty:
    - Reducing the support surface
    - Progression by lengthening the lever/dynamization
    - Static-diagonal raising of arm/leg
    - Dynamic-diagonal movement of the extremities.
- E-technique in accordance with Hanke (e.g., "Kriechmuster" position).
- Therapeutic climbing: Tensing exercises via muscle chains while standing, 3D screw connection (Fig. 19.4).

Fig. 19.4 Therapeutic climbing: tensing exercises via muscle chains while standing, 3D screw connection

Fig. 19.5 Stabilization exercises in prone position to strengthen the extensors while controlling segmental stability (PBU)

Fig. 19.7 Strengthening back/arms using gymstick – seated row

- Spiral dynamic stabilization for foot and leg axis.
- Stabilization exercises in prone position to strengthen the extensors while controlling segmental stability (PBU) (Fig. 19.5).
- Stabilization while standing in conjunction with Vitality® band exercises in upright straight and ventrally flexed position (Fig. 19.6).
- Stabilization exercises in lateral position with short lever (rotation resistance on pelvis and lower ribcage).
- Strengthening back/arms using gymstick – seated row
- Technique training and initial strengthening of axial compression: neck press, front press, squats in knee-bend stands including isometric holding phases at 120° and 100° (Fig. 19.8).
- Symmetric and reciprocally asymmetric resistance combinations via shoulder blade and pelvis.
- Exercising movement transitions with muscular stabilization (Fig. 19.9).
- Integration training for everyday life/workplace (functional and ergonomic).
- Redcord® (starting position: supine position, standing) (Fig. 19.10).
- Pilates system: reformer (Fig. 19.11).
- Exercise pool.
- Tai Chi: working on the initial steps, bear stance (Fig. 19.12).

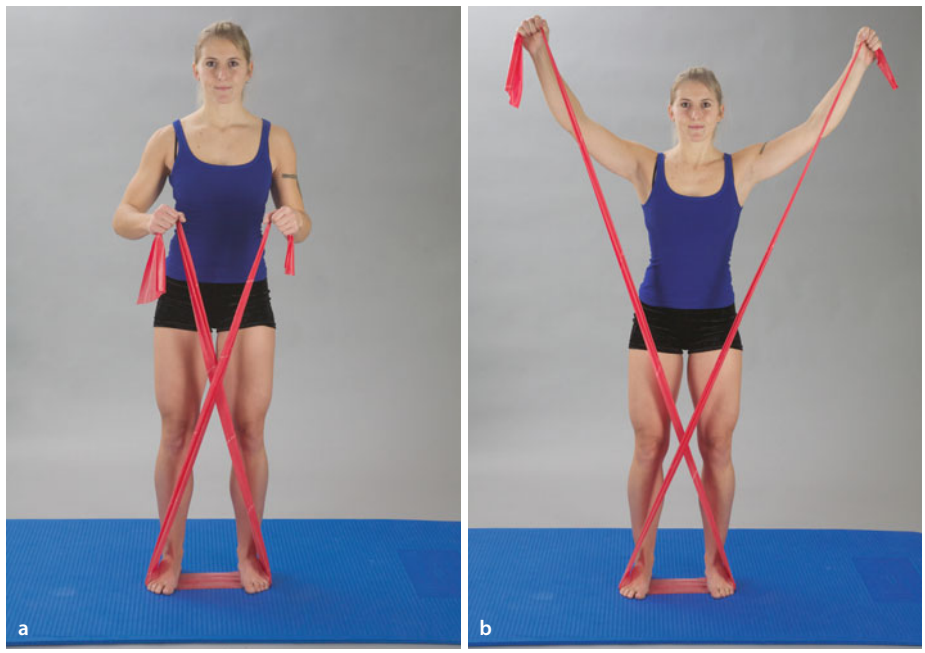

Fig. 19.6a,b Stabilization while standing in conjunction with Vitality® band exercises in upright straight and ventrally flexed position

Fig. 19.8a,b Technique training and initial strengthening of axial compression

Fig. 19.9 Exercising movement transitions with muscular stabilization

Fig. 19.10 Redcord®, starting position: standing

Fig. 19.11 Pilates system: use of the reformer

Practical tip

- Going to vertical as soon as possible
- Low intensity in all stabilization exercises to prevent general muscle activation
- **Cave:** In the case of exercises in the exercise pool in the 3rd week post-op, there is a risk of instability due to a lack of ability to stabilize!
- Sitting with stabilizing basic tension
- Integrate breaks and physical perception training regularly into the daily routine (plan in breaks lying down)
- Walking
- Back training program (practice and theory)

Physical measures

- Foot reflexology massage.
- Lymph drainage (note: swelling in the epigastric region and inguinal region).
- Acupuncture massage (APM).
- Hot pack on the abdominal region.
- Massage.
- Electrotherapy: depressant current, microstimulation current or exponential current in the case of denervated muscles.
- CTM.
- Hot rolls.

All exercises should be performed while observing segmental stabilization, i.e., first build tension and then perform complex movements.

19.2.2 Medical training therapy

- General accompanying training of the cardiovascular system:
  - Ergometer training: 2 × 10 mins with low load at 20-50W
  - Treadmill exercise as walking training with slight incline (maximum 5%)
  - Elliptical/cross trainer: 2 × 10 mins with low load at approx. 50W
  - Orthopedic walking.

Fig. 19.12a-c Tai Chi: working on the initial steps, bear stands

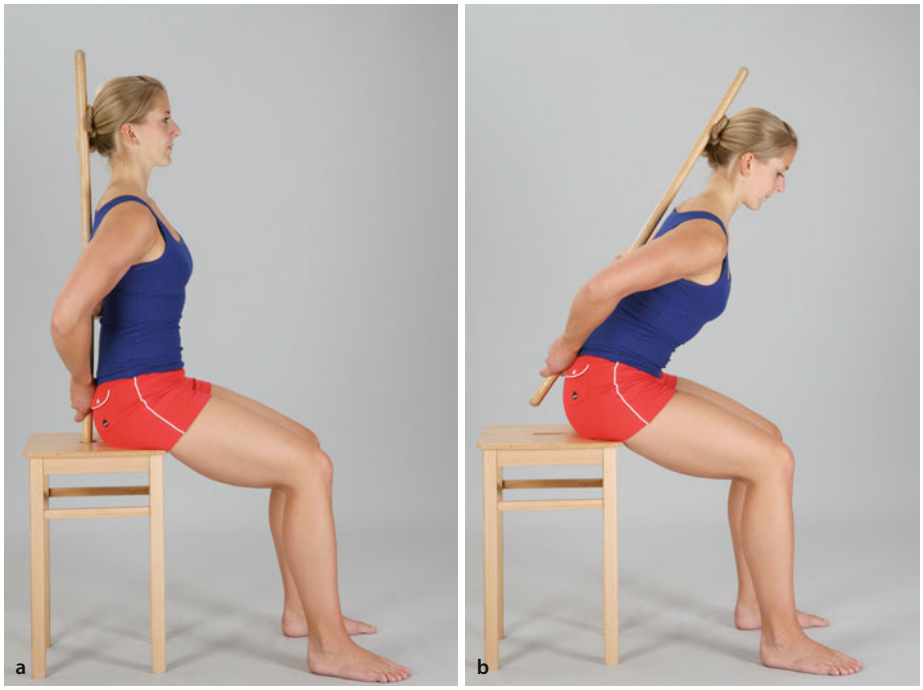

Fig. 19.13a,b Physical perception training regarding position and movement of the lumbar spine and the pelvis, bar as controlling the position of the parts of the body

Sensorimotor function training

- Segmental stabilization on unstable support surfaces (balance board, Dotte swing, Posturomed).
- Pilates training, core stability (power house).
- Physical perception training regarding position and movement of the lumbar spine and the pelvis (Fig. 19.13):
  - Feldenkrais, Tai Chi.

Strength training

- Intramuscular activation via isometry (Fig. 19.14).
- Strength endurance training, (adjusted to plans; focus on local stabilizers; 4 × 20 (–50) repetitions within absolutely pain-free range).

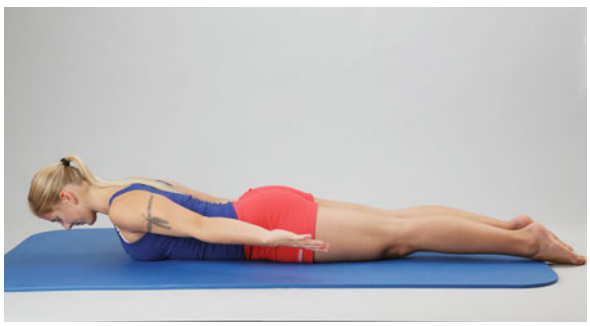

Fig. 19.14 Intramuscular activation via isometry

- Isometric activation through long holding times with low intensity (20-30% with holding time of over one minute)
- Overflow via movement of extremities with stabilized lumbar spine (segmental stabilization): Vitality® band, cable pulley, Pezzi ball, dumbbells in different starting positions.
- Mono-directional training from stable starting positions: e.g., supine position, minimal raising of a leg with stabilized pelvis.
- Axial compression: squats, dumbbell press.
- Extension static stabilization:
  - High dead lift
  - Front press (Fig. 19.15a,b)
  - Barbell rowing (Fig. 19.15c,d).
- Rotation static stabilization: dumbbell front raise (Fig. 19.16).
- Lateral static stabilization: dumbbell lateral raise (Fig. 19.17).
- Intensification/rhythmization through breathing.

Therapeutic climbing

- Weight transferring training on middle handles while standing.
- Step alternating training on large steps with stable grip fixation.

Fig. 19.15a–d Extension static stabilization. **a,b** Front Press, **c,d** Barbell rowing

Fig. 19.16 Rotation static stabilization: dumbbell front raise

Fig. 19.17 Lateral static stabilization: dumbbell lateral raise

19.3 Phase III

Goals (in accordance with ICF)

Goals of phase III (in accordance with ICF)

- **Physiological function/bodily structure:**
  - **Improving physical perception**
  - **Optimization of segmental stability**
  - **Restoring core stability/muscular corset**
  - **Improving mobility**
  - Improving sensorimotor function
  - Improving muscular strength
  - Pain relief/management
  - Improving physiological movement pattern
- **Activities/participation:**
  - Correction of improper posture and movement pattern
  - Developing active coping strategies for dealing with pain
  - Hints and tips for self-sufficiency when meeting the challenges of daily routines
  - Learning a home training program
  - Promoting mobility (maintaining and changing body position, walking and movement with spine stabilized by the muscles)
  - Breaking down barriers that impede participation (anxiety)
  - Rehabilitation into work, sport
  - Ergonomic advice for everyday and working life

19.3.1 Physiotherapy

Patient education

- Discussing the content and goals of treatment with the patient.
- Ergonomic advice (everyday/work/sport).
- Information about the provision of aids.
- Reducing anxiety further and inspiring motivation for physical activity by providing the patient with further information regarding the level of wound healing and the associated load bearing capacity of the tissue.
- Showing the importance and providing motivation to continue a home training program to ensure the long-term success of the operation.

Improving mobility

- Improving pelvic tilt by learning physiological midposition.
- Mobilization of neural structures: transition from slider to tensioner techniques: slump, SLR, PKB.
- Segmental mobilization (**Cave:** Proceeding carefully in the direction of the segments that underwent surgery, just like following spondylodesis).
- Continuation of sacrum techniques: mobilization around the various sacral axes. Supported position to improve the intensity of the techniques: Head rotation/extension or flexion position, lumbar spine/lower positioning of the spinae.

- Soft tissue treatment:
  - Treatment of the surrounding muscles:
  - Piriformis muscle, psoas muscle, iliac muscle, quadratus lumborum muscle, tensor fasciae latae muscle, pelvic floor muscles, adductors
  - Treating ligaments through cross-fiber massage: sacrotuberous ligament, spinotuberal ligament, iliolumbar ligament
  - Treatment of the fascia via pressure and release techniques: thoracolumbar fascia, surface spine fasciae
  - Visceral mobilization depending on findings, e.g., small intestine, large intestine, ileocecal valve, renal fasciae.
- Monitoring the mobility of the cervical spine, the thoracic spine, and depending on findings, treatment with manual techniques or actively through neck presses with barbell while lumbar spine is kept stabilized.
- Mobilization of the thoracolumbar transition – crossing the AP and PA muscle chain lines as well as the descending anterior posterior gravitational lines (center at the level of the Th11 and Th12).
- Controlling pelvic position: up slip, down slip, inflare and outflare, ilium rotations, L5 (rotation position as a result of the fixation of the lower thoracic spine or hip joint).
- Checking the cause-effect chain, for examples see appendix.

Regulation of vegetative and neuromuscular functions

- Treatment of neurolymphatic reflex points depending on findings.

Improving sensorimotor function

- Beginning coordination and balance training with and without small equipment:
  - Bodyblade, Boing (Fig. 19.18a)
  - Pilates (Fig. 19.18b)
  - Gyrotonic (Fig. 19.18c)
- Training on unstable surfaces (balance pad, MFT, balance board, Pezzi ball, platform etc.) (Fig. 19.19).
- Exercise pool:
  - Exercises against resistance (e.g., swimming flat, ball etc.)
  - Aqua jogging
  - Coordination training.

Stabilization and strengthening

- Increasing segmental stabilization – variations in all starting positions
  - Basic tension (20% muscle tension), controlling local stability!
  - Transition to everyday loads
  - Standing taking 3P foot coordination into consideration
  - Support functions
  - Knee-bends/interval training/climbing stairs
  - Progression by lengthening the lever and dynamization

Fig. 19.18a–c Coordination and balance training with small equipment. **a** Bodyblade, **b** Reformer, **c** Gyrotonic

Fig. 19.19 Training on unstable surface: standing on one leg on the Posturomed

- Initial rotation variants
- Gait training.

- Developing stabilization over longer isometric lever in lateral position: rotation resistance on the pelvis and shoulder girdle or pelvis and abducted arm in various directions.
- Exercises with the Vitality® band from different starting positions.
- Abduction of the leg from lateral position with fixed lumbar spine.
- Rhythmic stabilization in various starting positions: making more advanced through short, rapid movements to exert constantly different stimulus on the muscles of the back.
- Initial muscle-building training and initiation of rotation exercises while standing, in supine position, lateral position with traction devices (unilaterally, bilaterally).
- Stabilization via the muscle chains (Fig. 19.20).
- Increasing exercises from prone position (e.g., "swimming") (Fig. 19.21).
- Climbing onto stool (one-leg) with fixed lumbar spine (3D screw connection).

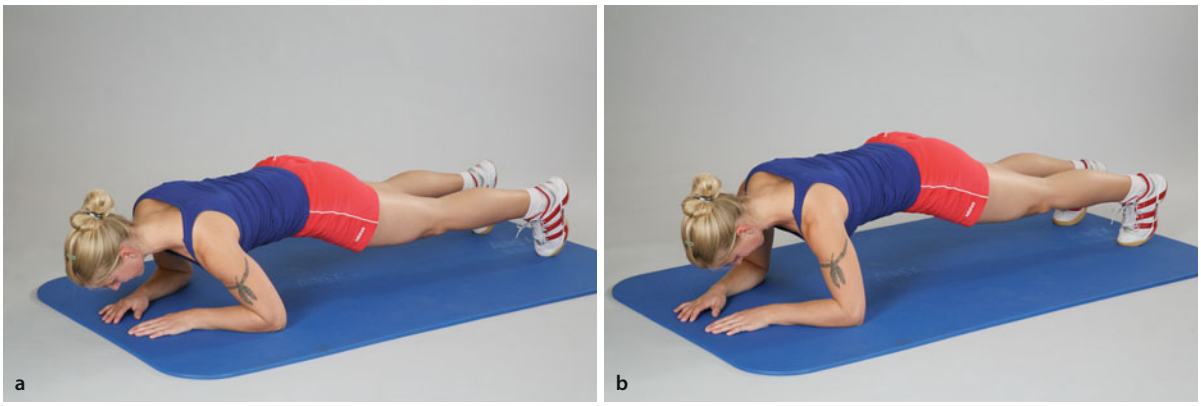

Fig. 19.20a,b Stabilization via the muscle chains, e.g., plank

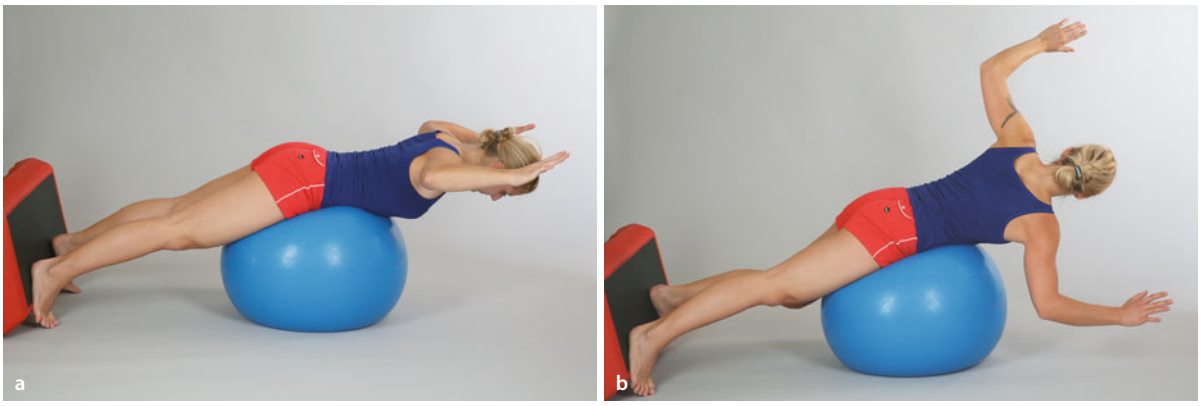

Fig. 19.21a,b Increasing exercises from prone position: "swimming"

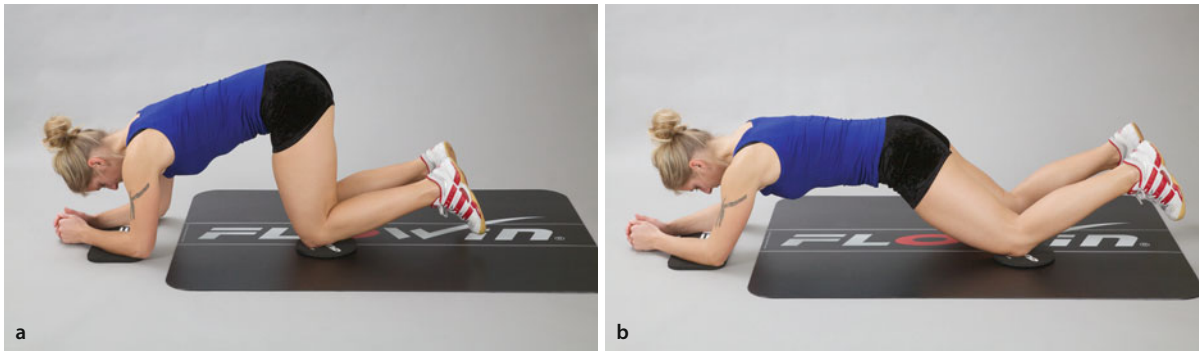

Fig. 19.22a,b Increased training of the leg and glute muscles as well as abdominal muscles: Flowin mat, "bridge"

- Dynamic Pezzi ball exercises (in accordance with Klein-Vogelbach: cowboy, cocktail etc.).
- Increased training of the leg and glute muscles as well as abdominal muscles: Flowin mat, "bridge" (Fig. 19.22).
- Everyday activities: movement transitions with segmental stabilization (lifting and bending training).

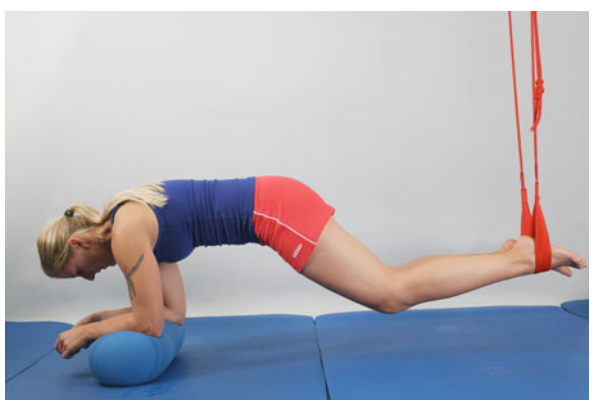

Fig. 19.23 Redcord®: high intensity for the transverse abdominal muscle

- Stepper training.
- Redcord®: high intensity for the transverse abdominal muscle (Fig. 19.23).
- Start with two-leg and transitioning to one-leg bridging (Fig. 19.24a)
- Intensification with activation of hip flexor muscles on the opposite side (Fig. 19.24b).

Physical measures

- Traditional massage of the thoracic spine and cervical spine, gluteal area (careful with the lumbar spine).
- Marnitz key zone therapy: reflex points of the sciatic nerve.
- Application of heat (ventrally in accordance with TCM).
- Acupuncture massage (APM).
- Foot reflexology massage to treat symptom zones and vegetative zones.

19.3.2 Medical training therapy

- General accompanying training of the cardiovascular system

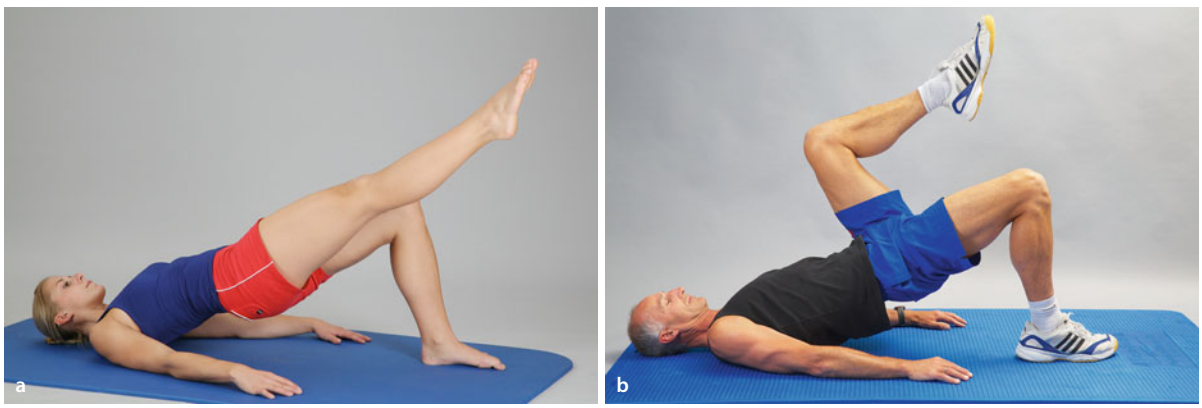

Fig. 19.24 **a** Start with two-leg and transitioning to one-leg bridging, **b** Intensification with activation of hip flexor muscles on the opposite side

- Ergometer training
- Treadmill exercise as walking training (4-5km/hour) with approx. 10% incline
- Crosswalker
- Orthopedic walking.

Sensorimotor function training

- Segmental stabilization in various positions and in connection with various exercises
  Starting positions: standing, lateral position, kneeling.
- Controlling mobilization of the lumbar spine within an average range of motion (e.g., quadrupedal position, sitting)
  Task: rolling and straightening up while moving the pelvis.
- Slow controlled transfer of weight:
  - Diagonal arm/leg pattern with stabilized lumbar spine (with and without weight).
- Initiating feed forward:
  - Taking/passing small weights from different positions.
- Physical perception training regarding position and movement of the lumbar spine and the pelvis.

Strength training

- Intramuscular activation via isometry: Plank variants (Fig. 19.25a–c) or on unstable support surfaces (Fig. 19.25d,e).

Fig. 19.25a–e Intramuscular activation via isometry. **a–c** Plank variants, **d,e** On unstable support surfaces

From. 19.26a–e Segmental movement control. **a** Flexion/extension movement: dead lift, **b–e** Rotation movement: One-armed rowing **(b,c)** Steps-up **(d),** Lunges **(e)**

- Strength endurance training, adjusted to plans; focus on local stabilizers, 4 × 20 (–50) repetitions within absolutely pain-free range.
- Isometric activation through long holding times with low intensity (20–30% with holding time of over one minute).
- Overflow over movements of the extremities under controlled lumbar spine movement (segmental control).
- Segmental movement control:
  - Flexion/extension movement: Good Morning, back extension, Stiffed Leg, Dead Lift (Fig. 19.26a)
  - Lateral flexion movement
  - Rotation movement: Barbell rotation, bend-over rowing, one-armed rowing, step-ups, lunges (Fig. 19.26b–e).
- Multi-directional training from variable starting positions, e.g., stepping forwards, pulling cable pulley diagonally from low and behind to high and in front, Haramed (Fig. 19.27).
- Hopping and lifting on the cable pulley in diagonal traction direction in half-standing and standing on one leg.
- Intensification/rhythmization through breathing.
- Gyrotonic (Fig. 19.28).

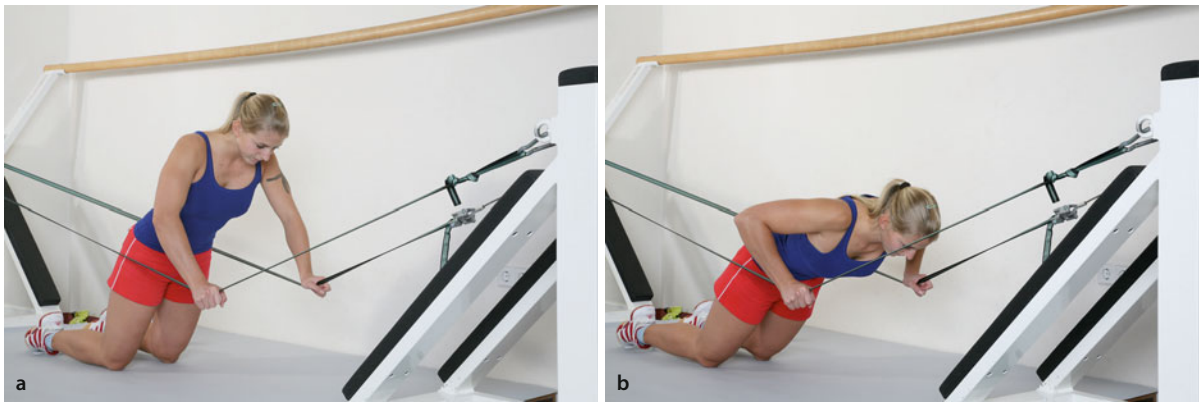

Fig. 19.27a,b Multidirectional training from starting position, Haramed forearm plank

Fig. 19.28 Gyrotonic

Therapeutic climbing

- Alternating step training in the positive wall area, alternating movements (up/down, side to side), paying attention to pelvic stability.
- Weight transferring training on middle handles in vertical wall area.
- Alternating step training on large steps with variable grip fixation.
- Approval of rotational hand movements (Fig. 19.29).
- Isokinetics: stabilization while standing against stochastic impulses (Fig. 19.30).

Fig. 19.29 Approval of rotational hand movements

19.4 Phase IV

19.4.1 Sports therapeutic content for the spine

Phase IV refers to the complete rehabilitation of the spine.

General

- Preparing for exercise by practicing the type of load with a lower weight.
- Maximum strength training of the global muscles (two to three times per week) as overflow training.
- Spreading strength training units over muscle groups and different days.
- Observing classic training principles.
- Inclusion/coordination with competition planning/periodization.
- Integrate sport-specific exercises into each training session.

Sensorimotor function training

- Integration into each training unit following the warm-up stage.

Fig. 19.30 Isokinetics: stabilization while standing against stochastic impulses

Fig. 19.31 Speed skating: simulation on the slide board

- 3D fine coordination: e.g., grip/steps on climbing wall.
- Physical awareness from sport-specific movement (Fig. 19.31): own internal error analysis, comparing errors in own/external and video analysis, e.g., speed skating on slideboard
- Unstable environments, increased requirements: e.g., one-legged knee-bends on Haramed, juggling while pedalo boating, push-up on Haramed, Redcord® training with Indo board (Fig. 19.32).
- Feed forward training e.g., passing/catching balls of different weights or sizes, landing with eyes closed, landing on unknown (visually obscured) surface.

Strength training

- Intramuscular coordination training in full range of motion, 6 × 3–5 reps:
  - Machine-supported: e.g., leg press, lat pull, back extension
  - Weights training with dumbbells or barbells: Good Morning, high dead Lift, barbell rotation, barbell rowing, walking lunges, squats
  - Explosive loads (positive jumps).
- Reactive loads (braking with barbell).
- Learning segmental movement control:
  - Rapid extension exercise
  - Eccentric rotary movements in extension
  - Eccentric rotary movements in flexion.
- Throwing training.
- Jump training.
- Training of the local stabilizers (transverse abdominal muscle, multifidus muscles; dynamically as functional endurance performer, high number of repetitions with low intensity or long holding times).
- Controlling load via the sequencing of various exercises rather than series of exercises, (Fig. 19.33).
- Push-up options:
  - Wide and close arm positions
  - Hands or feet elevated
  - One hand raised on step
  - Clasp hands.
- Sumo with kettlebell.
- One-legged deadlifts with two weights.
- PNF raising with Pezzi ball on one leg
  - Start: deep one-legged knee bends, Pezzi ball to the side near the foot
  - End: upright posture, Pezzi ball on the other side of the body next to the head.
- Multi-directional training from variable starting positions:
  - Imbalanced squats (Fig. 19.34a,b)
  - Lunges with torso rotation in conjunction with suspended Pezzi ball
  - Rotational standing stabilization (Fig. 19.34c).
- Segmental regulation:
  - Ability for adjusted strength control (high load, high degree of tension and stiffness, low load, low tension and flexibility)
  - Reactive-situative loads, training in the stretch-shortening cycle (e.g., long jump, ski jump)
  - Plyometric training (pre-stretching + maximum contraction with competition-specific movement):
    Structure:
    General
    Versatile targets
    Specific

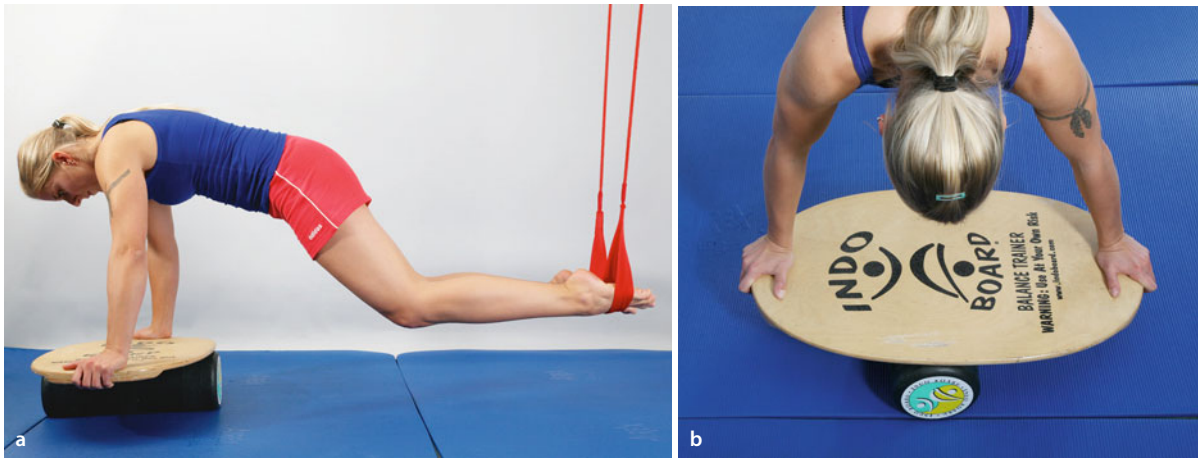

Fig. 19.32a,b Unstable environments, increased requirements: Redcord® training with Indo-Board

Fig. 19.33a,b Controlling load via the sequencing of various exercises:

- **Tennis player example:**
  One-armed barbell rotation
  Throwing and holding weights (stopping)
  Tennis serve with maximum quality.
- Development of condition variables:
  - Precision control (e.g., pelvic position during push-up) (Fig. 19.35a)
  - Time control (e.g., control time until stabilization)
  - Situation control (e.g., choice of responses to a signal)
  - Complexity control (focus on segmental stabilization under higher requirements) (Fig. 19.35b,c).

Therapeutic climbing

- Variable climbing training in different degrees of difficulty

Examples for training programs at the end of rehab

Normal person

- Toning: Roman chair, 2–3 × 15 reps
- Compression: dead lift, 3 × 10 reps, 30% of 1 RM (repetition maximum)
- Quick eccentric rotation: Good Morning imbalance rotation, 3 × 5 reps (eccentric, fast, acyclic, breaks every three mins)

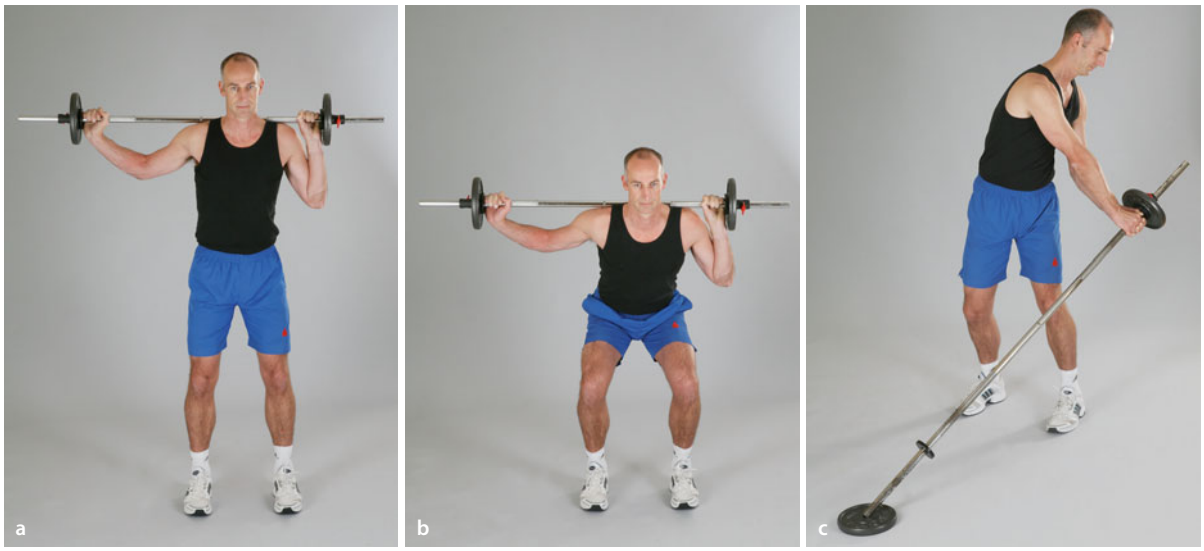

Fig. 19.34a–c Multi-directional training from variable starting positions. **a,b** Imbalanced squats, **c** Rotational standing stabilization

Fig. 19.35 Development of condition variables. **a** Precision control: Pelvic position during push-up, **b,c** Controlling complexity: focus on segmental stabilization under higher requirements

Fig. 19.36a,b Cooling down: Russian twist, no flexion of the lumbar spine and slow, controlled movements, 3 x 8-12 reps

- Hypertrophy: dumbbell rowing one-armed, 3 × 5 reps (explosive, eccentric, acyclic, right and left)
- Cool down: Russian twist, no flexion of the lumbar spine and slow, controlled movements, 3 × 8–12 reps. (Fig. 19.36).

Marathon runners

- Sit ups, 2 × 10–15 reps
- Good Morning, 2 × 20 reps 40–50% of 1 rotator cuff
- Walking lunges, 3 × 20–30 reps, right and left
- Step-ups cyclically right and left, 25cm step height; 3 × 20–30 reps
- Lateral pull-down.

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Rehab training in water

Andreas B. Imhoff, Knut Beitzel, Knut Stamer, Elke Klein

A. Imhoff et al. (Hrsg.), *Rehabilitation in Orthopedic Surgery*,
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20.1 Preliminary considerations and preparation

- In general, the following notes apply for training in water:
- The time and symptom-based approach from phases I-IV also remains a basis of rehab training in water.
- The surgeon's instructions, the permitted range of motion, pain and signs of inflammation are to be considered in the program and the load guidelines are to be adapted accordingly.

20.1.1 Advantages of training in water

- In water, movement with reduced gravity force with limited or without weight load can begin earlier than on land.
- Effect of hydrostatic pressure on the influence on edema and improving circulation.
- Relaxing the muscles through water temperature.
- Using the buoyancy force of the water for relaxation.
- Using the resistance of the water and inertia in training control.
- Pain relief.

Muscle strengthening in terms of strength training through water therapy is only possible to a certain extent.

20.1.2 Absolute and relative contraindications

- No therapy in water in the event of:
  - Dizziness
  - Fever and inflammatory processes
  - Open wounds
  - Infectious diseases
  - Incontinence
  - Hydrophobia
  - Skin illnesses
  - Cardiovascular and pulmonary illnesses.

20.1.3 Creation of a training unit

- Warming up.
- For phases II, III and IV, bring together content from the areas of "movement", "strength" and "coordination and endurance" and create areas of focus.
- In phase IV, also use of hand paddles, fins and traction ropes.

The exercises should simulate everyday and sport-specific movements.

- 1. Training unit on land with the following content:
  - Explaining the influence of water on movement to the patient
  - Physical awareness: preservation, tensing – relaxation
  - Learning fundamental terms, e.g., scapular setting, humeral head centering, segmental stabilization of lumbar spine and supporting leg stability
  - Independence with aids/position
  - Explaining any potential medical restrictions, "safeties".
  - Specific notes for training in water
- The use of resistance/force is controlled partly by the speed of the movement, i.e., the faster the movement, the higher the muscle activity (for angular speeds of 30°/s – 45°/s, lower EMP amplitudes of muscle activities than on land).
- Balance reaction: When immersing deeper than thoracic vertebra 11, the body experiences buoyancy dominance. This required an increased balancing reaction by the patient.

20.2 Spine

General information:

- Where possible, the buoyancy should be used to support the movements.
- Begin with 1–2 sets of 10–15 repetitions.
- Perform the exercises within the patient's individual range of motion, ensuring it is pain free, while observing the segmental stabilization of the spine that the patient has learned.

20.2.1 Focus on movement control

- Pelvic tilt posterior/anterior to find a stable spinal position.
- Static stabilization exercises in mini-squat:
  1. Hold the swimming float in front of the body against the water resistance and push downwards (Fig. 20.1a)
  2. Move swimming float forwards and backwards
  3. Push the swimming float downwards and then laterally guide it near the body with one hand and move up and down (Fig. 20.1b)
  4. As in 3., then bring weight over to the opposite leg while at the same time raising the leg (Fig. 20.1c).

Fig. 20.1a–c Stabilization exercises statically in mini-squat. **a** Push the swimming float downwards against water resistance in front of the body, **b** Push the swimming float downwards and then guide laterally near the body with one hand and move up and down, **c** Bring weight round to opposite leg and lift the leg on the same side

- Hip movements with stabilized lumbar spine while standing with short lever:
  - Flexion/extension
  - Abduction/adduction
  - IR/ER in 90° flexion for hip joint and knee joint
  - Writing numbers on pool floor, e.g., a figure of eight, semicircles (on tiptoes while standing on one leg)

Fig. 20.2 Walking forwards with stabilized lumbar spine, then holding float in both hands (eyes open and closed)

- Walking forwards/backwards/sideways with stabilized lumbar spine: as a more advanced option, hold the float in both hands and walk against resistance (eyes open and closed) (Fig. 20.2).
- For balance and proprioception:
  - Tandem walking forwards and backwards: Like a tightrope walker, where possible the heel of one foot should be put down in front of the toes of the other and vice versa when walking backwards.
- Monitoring the passive extension in the hips or lumbar spine in prone position:
  - Patient begins standing and stabilizes himself/herself by holding the bar with an underhand grip. Legs are bent in front of the body. A buoyancy device is held between the thighs. Raise the legs in a controlled way into extension. Remove any buoyancy device when returning. In order to strengthen the abdominal muscles, repeat exercise without the buoyancy device.

20.2.2 Focus on Mobility

- Hip joint flexion up to the chest
  - Vertically: standing with hands on the pole, on one leg
  - More advanced: vertically: standing with hands on the pole, on both legs
  - Patient stabilizes himself/herself with hands on the bar from behind. A buoyancy device is located below the knees: Perform flexion and remain in final position for between one and two seconds and then return to starting position (Fig. 20.3).
- Sitting on a buoyancy device, patient stabilizes himself/herself with hands on the bar:
  - Mobilization in flexion/extension through pelvic tilt and straightening

Fig. 20.3 Hip joint flexion up to the chest: Patient stabilizes himself/herself with hands on the bar from behind, with a buoyancy device located below the knees

Fig. 20.4 Hip movements with stabilized lumbar spine while standing with long lever: flexion/extension

- Mobilization in lateral flexion by shifting weight to a tuber
- Mobilization in rotation.

20.2.3 Focus on strength

- Hip movements with stabilized lumbar spine while standing with long lever:
  - Flexion/extension (Fig. 20.4)
  - Abduction/adduction
  - IR/ER in 90° hip joint and knee joint flexion.
- PNF diagonal patterns while standing.
- Unilateral squats.
- Static lunges (Fig. 20.5).
- Forward lunges with feet hip width apart, arms in 90° abduction. Patient takes a large step forwards, remains in position for two seconds and returns to starting position.

Fig. 20.5 Static lunges

20.2.4 Swim pattern and sport

- Aqua jogging in deep water.
- Aqua cycling.
- Freestyle and backstroke techniques.
- Squats and exploding lunges.
- Running on the spot with ground contact – forward and backward.

20.3 Shoulder

General information:

- Where possible, the buoyancy should be used for support in shoulder joint movements.
- Begin with 1–2 sets of 10–15 repetitions.
- Perform the exercises within the patient's individual range of motion, ensuring it is pain free, while remaining in line with his/her target activities.

20.3.1 Focus on Mobility

- Walking forwards and backwards, potentially with a buoyancy device under the arms when walking forwards.
- Shoulder circles: standing with upper body tilted forwards and then moving arm clockwise and anticlockwise
- The same as shoulder alphabet, capital letters.
- Shoulder flexion and extension to 90° (Fig. 20.6), then slowly increased where approved, supported by a buoyancy device, also in prone position with snorkel.
- Shoulder abduction and adduction within 90°, potentially with buoyancy support.

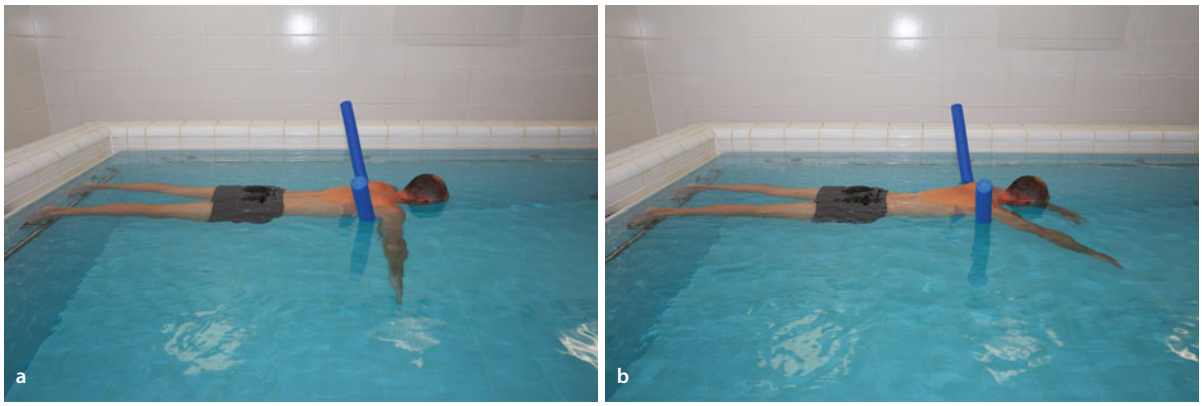

Fig. 20.6a,b Shoulder **a** Flexion and **b** Extension to 90°

Fig. 20.7 Internal rotation and external rotation of the shoulder with weight, supported by a buoyancy device

- Shoulder internal rotation and external rotation with dumbbells, buoyancy device-supported (Fig. 20.7)
  - Supine position, feet supported against the wall, neck collar around the neck to facilitate the movements, hold a bar in both hands, abduction/adduction
  - Standing: holding a bar in both hands to facilitate the movements, movement in flexion/extension, abduction/adduction.
- Internal and external rotation of the shoulder within 60° in neutral position.
- Scapular movements with the shoulder joint below the horizontal line: protraction, retraction, elevation, depression → scapular clock (reversing fixed end ↔ mobile end) potential arm usage to facilitate the shoulderblade movements, e.g., rowing.
- Elbow joint mobilization: **Cave** in the event of LBT tenodesis!
  - Traffic cop (neural mobilization: standing in mini-squat position. The arms are positioned at scapula level, and the patient performs flexion and extension o the elbow joint)
  - Standing with back to the wall: Bar in both hands and perform flexion/extension in shoulder joint with shoulder in rest position of the glenohumeral joint.
- Wrist mobilization.

20.3.2 Focus on strength

- Approx. 6 weeks post-op for open rotator cuff reconstruction.
- 2–3 sets with 10–15 repetitions.
- Pain-related limitation of range of motion.
- Slowly increasing range of motion and speed.
- Continue the emphasis on "Movement" (▶ Section 20.4.1).
- Shoulder alphabet, capital letters.
- Horizontal shoulder abduction and adduction movements.
- Reciprocal arm swings.
- Exercises against the wall:
  - Starting position: standing in mini-squat with back supported against the wall, short/long lever:
    Movements of the shoulder joint in elevation/extension up to 90°
    Movements of the shoulder joint in abduction/adduction up to 90°.
- Flat paddle movement in a figure eight movement
  - Starting position: standing free with the arms in front of the body. The shoulder movements are IR or ER, EGB and wrist flexion and extension, radial and ulnar deviation (flat paddling in a figure of eight) (Fig. 20.8).
- Training the support function:
  - Applying pressure to swimming float at scapular level (Fig. 20.9a)

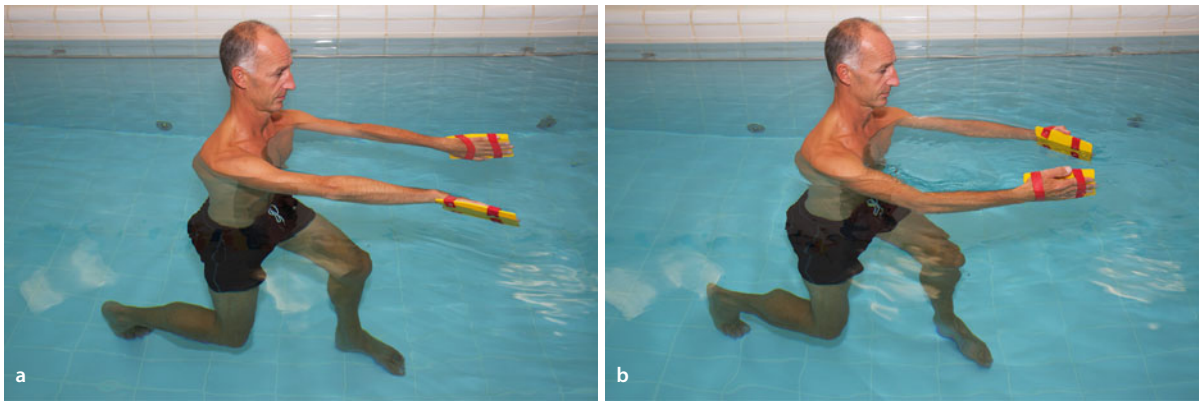

Fig. 20.8a,b Flat paddle movement in a figure eight movement

- Parallel sliding
- Serratus anterior muscle bilaterally: buoyancy device under the hands (or forearms for short lever), standing with back to the wall in mini-squat, eccentric elevation and concentric depression against buoyancy device (Fig. 20.9b,c)
- Dynamic centering (short/long lever): rest forearm or hand on swimming float in neutral position and use the buoyancy to control HK eccentrically bilaterally and unilaterally during elevation/abduction (Fig. 20.9d,e).

- Modified Blackburn exercises 1-5

Blackburn et al. (1990) carried out an EMG analysis of ISP (infraspinatus), SSP (supraspinatus), SSC (subscapularis) and the teres minor to determine the optimum position for strength-building, with the following result: These muscles are best isolated and strengthened with the person in prone position and with the shoulder joint in external rotation. For improved practicality in water, the patient is to be in supine position supported by a buoyancy device and the exercises are not terminally performed and are therefore modified.

- Exercise 1: shoulder joint extension with ER; supine position, legs above buoyancy device, feet mounted on the bar; start with the arms next to the body with the palms face up. Then press the arms towards the ground (teres minor muscle)
- Exercise 2: horizontal abduction at 90°: same starting position, starting with arms at 90° abduction with palms towards the floor. Horizontal abduction towards the ground, with ER (Fig. 20.10a)
- Exercise 3: horizontal abduction with ER: Start in the same way as in exercise two, but with the thumbs to the ground. In horizontal abduction the shoulder joints are rotated externally as far as possible (ISP; SSP; teres minor muscle)
- Exercise 4: like exercise 3 but with 100° abduction
- Exercise 5: high ER: Supine position, arms in 90/90 with the forearms out of the water: maximum pain-free ER towards the water (Fig. 20.10b,c).

20.3.3 Focus on coordination, endurance

- Approx. eight weeks following open reconstruction.
- Continue the emphasis on "Movement" (▶ Section 20.3.1) and "Strength" (▶ Section 20.3.2).
- Standing: reciprocal paddling arm stroke

Intensification: horizontal arm stroke while standing with paddles.

- Walking with arm swing.
- PNF diagonal patterns while standing, more advance option: bilateral symmetrical and asymmetric/reciprocal arm pattern, trust and withdrawal (Fig. 20.11).
- Paddling with head forwards (10-12 weeks post-op)
  - Backwards arm strokes and passage phase
    Starting position: supine position
    Knee joint supported by buoyancy device, later free in the water
  - Intensification: supine position with feet in front; arm swing
- Exercises with the tube (10–12 weeks postop.)
  - Abduction with ER
  - Abduction with IR
  - IR/ER in neutral
  - Elbow extension and flexion.

Fig. 20.9a–e Initiating support function. **a** Applying pressure to swimming float at scapular level, **b,c** Serratus anterior muscle bilaterally: Buoyancy device under the hands, standing with back to the wall in mini-squat, eccentric elevation and concentric depression against buoyancy device, **d,e** Dynamic centering: rest hand on swimming float in neutral position and use the buoyancy to control HK eccentrically during elevation/abduction

20.3.4 Training depth perception

- Shallow water, standing with back to the wall in mini-squat, hands/forearms on buoyancy device; in front of the patient is a tensed rope on which various objects are located (e.g., rubber ducks). The patient should attempt to "run into" the items where requested with his/her eyes closed.

20.3.5 Swim pattern and sport

- Exercises with Tube exercise band.
- Running with breaststroke arm movements.
- Nordic walking in water (Fig. 20.12).
- Aqua jogging in deep water with arm involvement (Fig. 20.13).
- Swimming techniques of all styles

Fig. 20.10a–c Modified Blackburn exercises. **a** Exercise 2: horizontal abduction at 90°: start with arms at 90° abduction with palms towards the floor. Horizontal abduction towards the ground, with ER , **b,c** Exercise 5: high ER: Supine position, arms in 90/90 with the forearms out of the water: maximum pain-free ER towards the water

Fig. 20.11 PNF diagonal patterns while standing

Fig. 20.12a,b Nordic walking in water

20.4 Hip

General information:

- Where possible, the buoyancy should be used for support in hip joint movements.
- Begin with 1–2 sets of 10–15 repetitions.
- Perform the exercises within the completely pain-free range and the individual's range of movement and in line with his/her target activities.

Note the surgical process:

- **Anterior access: no movement combination of hip flexion-ER-abduction**
- **Posterior access: no movement combination of hip flexion-IR-adduction**

Fig. 20.13 Aqua jogging in deep water with arm involvement. (© Ryffel Running, www.ruffelrunning.ch)

20.4.1 Focus on Mobility

- Walking forwards.
- Standing on tiptoes and raising toes alternately.
- Two-leg squats within the permitted range of motion.
- Hip abduction (observe range of motion).
- Hip flexion with or without buoyancy device (no more than 90°).
- Hip extension with stabilized lumbar spine.
- Knee flexion and extension
  - Writing numbers or certain shapes and circles while holding onto the edge of the pool
  - PNF diagonal patterns.

20.4.2 Training depth perception

- Guide the swimming float under the foot in different directions within the permitted range of motion (with open and closed eyes) (Fig. 20.14).
- Variants: guide a swimming float to specific points on the wall. First reach the point with open eyes then with closed eyes.

20.4.3 Focus on strength

- Continue exercises from the emphasis on "Movement" (▶ Section 20.4.1) and "Deep sensitivity" (▶ Section 20.4.2).
- Move forwards and backwards, initially without swimming float, then increase to raising the swimming float in front of the body.
- Walking on tiptoes.
- Side steps (do not cross the legs).
- Squats.
- Static lunges and walking lunges.
- Step ups and downs (Fig. 20.15).
- Cycling movement with the back at the poolside: with one leg or two legs (do not exceed the center line).

20.4.4 Focus on coordination, endurance

- Continue exercises from the emphasis on "Movement" (▶ Section 20.4.1), "Deep sensitivity" (▶ Section 20.4.2) and "Strength" (▶ Section 20.4.3).
- Writing numbers or certain shapes and circles without holding onto the edge of the pool.
- Cycling movement in the corner for a certain period.
- Two-leg and one-leg squats within different ranges of motion.
- Step ups forwards and sideways (Fig. 20.16).
- Walking at various speeds.
- Aqua cycling.
- Hip circle (moving both hips in different directions at the same time) in deep water with buoyancy device

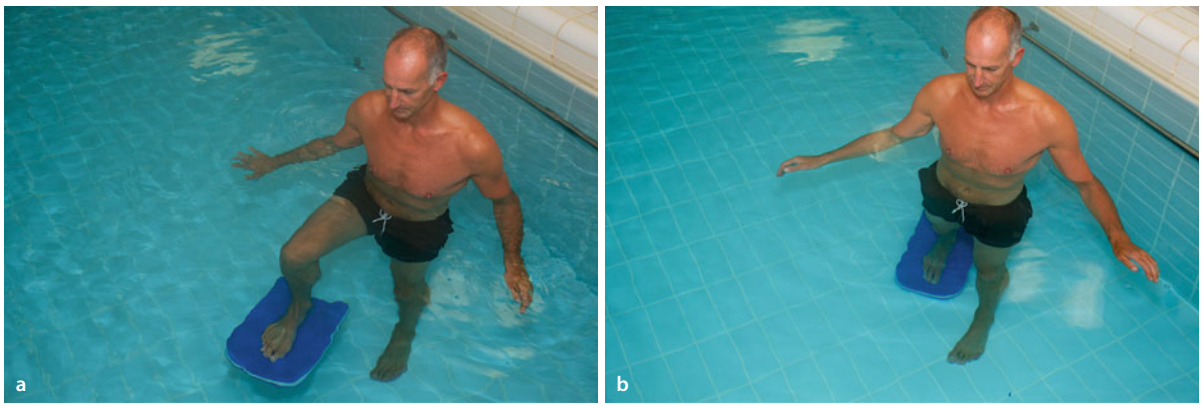

Fig. 20.14a,b Guide the swimming float under the foot in different directions within the permitted range of motion (with open and closed eyes)

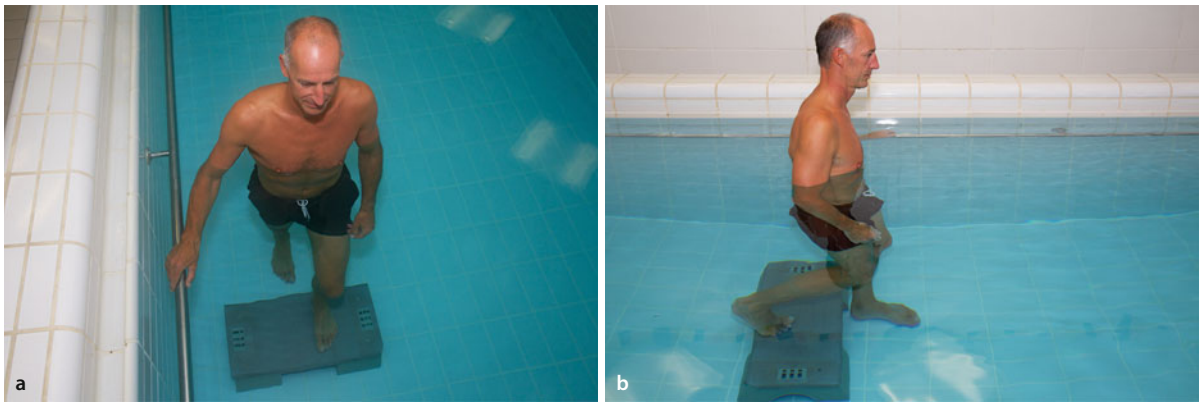

Fig. 20.15a,b Step ups and downs

Fig. 20.16 Step ups sideways

Fig. 20.17 Dynamic knee flexion with a held hip flexion (90°) with buoyancy device below the thigh

and holding onto the edge of the pool, making sure to stabilize the lumbar spine.
- Hopping from step position from the front to the rear foot and then back again for a certain period.
- Variants: hips in straddle position.

20.4.5 Swim pattern and sport

- Step ups und downs.
- Aqua cycling.
- Aqua jogging.
- Aqua nordic walking.
- Freestyle leg kicks while holding onto the edge of the pool.

20.5 Knee

General information:
- Where possible, the buoyancy should be used for support in knee joint movements.
- Begin with 1–2 sets of 10–15 repetitions.
- Perform the exercises within the completely pain-free range and the individual's range of movement and in line with his/her target activities.

20.5.1 Focus on Mobility

- Walking forwards, foot activity.
- Standing on tiptoes and raising toes alternately.
- Two-leg squats within the permitted range of motion.
- Knee flexion and extension while standing.
- Dynamic knee flexion with a held hip flexion (90°) with buoyancy device below the thigh (Fig. 20.17).
- Hip movements in all directions with stabilized lumbar spine.
- Writing letters or numbers with the foot.
- PNF diagonal patterns.

Fig. 20.18 Hip flexion, extension, abduction and adduction

20.5.2 Training depth perception

- Guide the swimming float under the foot in different directions (with open and closed eyes).
- Variants: guide a swimming float to specific points on the wall; reach the point firstly with open eyes, then with closed eyes.

20.5.3 Focus on strength

- Continue exercises from the emphasis on "Movement" (▶ Section 20.5.1) and "Deep Sensitivity" (▶ Section 20.5.2).
- Move forwards and backwards, initially without swimming float, then increase to raising the swimming float in front of the body.
- Walking on tiptoes.
- Side steps.
- Squats.
- Static lunges and walking lunges.
- Step ups and downs.
- Hip flexion, extension, abduction and adduction (Fig. 20.18).
- Cycling movement with the back at the poolside: with one leg or two legs.

20.5.4 Focus on coordination, endurance

- Continue exercises from the emphasis on "Movement" (▶ Section 20.5.1), "Deep sensitivity" (▶ Section 20.5.2) and "Strength" (▶ Section 20.5.3).
- Cycling movement in the corner for a certain period.
- Two-leg and one-leg knee-bends.
- Step ups forwards and sideways.
- Walking forwards at various speeds.

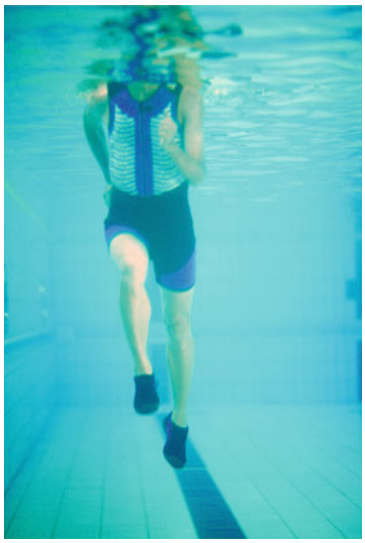

Fig. 20.19 Aqua jogging forwards. (© Ryffel Running, www.ruffel-running.ch)

- Dynamic side steps.
- Aqua cycling.
- Hip circle (moving both hips in different directions at the same time) in deep water with buoyancy device and holding onto the edge of the pool, making sure to stabilize the lumbar spine.
- Hopping from step position from the front to the rear foot and then back again for a certain period.
- Variants: hips in straddle position.

20.5.5 Swim pattern and sport

- Step ups and downs.
- Aqua cycling.
- Aqua jogging backwards or forwards (Fig. 20.19).
- Aqua nordic walking.
- Freestyle or dolphin leg kicks while holding onto the edge of the pool or in swimming movements.

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Glossar and Subject index

A. Imhoff et al. (Eds.), *Rehabilitation in Orthopedic Surgery*,
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Glossar

Acupuncture massage This special massage method was developed by Willy Penzel almost fifty years ago and is based on the healing knowledge of Chinese medicine that has been tried and tested over millennia. In a healthy body, the ancient Chinese belief is that life energy ("chi") circulates continuously along precisely defined paths, the meridians. These form an energy cycle that is superior to other systems, and also provides an individual energy and body function maintenance.

Brisk Walking 6–8km/h.

CPM Continuous passive motion

Cryokinetics Alternate rubbing ice on the skin briefly (approx. 20 seconds) with low-lift therapeutic movement exercises (approx. two minutes), 3-4 repetitions per treatment unit.

Dynamic rotation Agonistic technique from the PNF concept: concentric contraction between agonist and antagonist alternately in PNF pattern without a rest phase.

EMG Electromyograph.

Facilitation Facilitating or stimulating motor activities.

Inhibition Inhibition or prevention of muscle contractions or never impulses.

Inhibition of antagonists Static muscle activity of the agonists in the PNF pattern against resistance from the therapist, in order to inhibit shortened/hypertonic muscles (= reciprocal inhibition).

INIT Integrated neuromuscular inhibition technique.

Irradiation "Overflow" or the spread of reactions and nerve impulses to given stimuli.

Kinematic chain Involvement of different segments of the body during an activity. Each segment is affected by the movement.

Load High = 70-80% of maximum reps; higher = body weight.

MET Muscle energy technique.

MFT Muscle function test.

Motor learning Three phase model in accordance with (1964): (1) Cognitive phase: learning is declarative/verbal (active speech center); focus on PT assignment, (2) Associative phase: individual movement components are associated with success and failure and retained or modified accordingly; the patient develops strategies to solve the task (sensorimotor and motor areas active), feedback particularly important, (3) Automatic phase: goal of learning; conscious control no longer required.

MT Manual therapy (in accordance with Kaltenborn-Evjenth, Maitland, Mulligan, Cyriax).

MTT Medical training therapy.

OAA Occiput-atlas-axis complex.

Overflow Response ranges from a stronger to a weaker section with a kinematic chain.

PKB Prone knee bend: testing neurodynamics in all symptoms in the area of the knee joint, thigh and upper lumbar spine (transferring power via the femoral nerve to the L2, L3 and L4 nerve root; lateral cutaneous nerve of the thigh with additional hip extension and adduction, saphenous nerve with the hips positioned in abduction and external rotation).

Pneumatic pulsation therapy Pneumatic pulsation therapy is based on the principle of cupping/suction massage; in any case, there is no fixed vacuum but rather a pulsing wave of negative pressure, which creates an interaction between suction and pressure relief.

PNF Proprioceptive neuromuscular facilitation, treatment concept on a neurophysiological basis.

Redcord® System Sling system concept for holistic active treatment and training; for the long-term improvement in discomfort on the muscular and skeletal system (training of weak links).

ROM Range of motion.

SLAP Superior labrum anterior to posterior, lesion in the area of the superior glenoid labrum.

SLR Straight leg raise. Testing the sciatic nerve for movement and extension compared to surrounding tissue; additional internal hip rotation, plantar flexion and inversion placing the deep peroneal nerve under tension; dorsal extension with eversion increases the tension of the tibial nerve; dorsal extension with inversion increases the tension on the sural nerve.

Slump The combination of cervical flexion and knee extension puts the nervous system under maximum tension: Test for all symptoms on the spine or in conjunction with the upper/lower extremity, but not in the case of symptoms of an unstable disc.

SSC Stretching-shortening cycle.

Strain-counterstrain Technique to treat tender and trigger spots.

Thrust pattern Ulnar and radial impact movement, modified arm pattern from the PNF concept.

ULNT Upper limb neural tissue (provocation) test.

ULNT 1 Main components of shoulder joint abduction – neurodynamics test with a focus on the median nerve (disturbance in the cranial area, brachial plexus).

ULNT 2a Main components of external rotation and shoulder joint depression – median nerve (distal parts of the median nerve, in the case of forearm complaints).

ULNT 2b Primary components of internal rotation shoulder joint – radialis brevis nerve (discomfort in the area of the supply site, such as epicondylitis lateral humeri, tenosynovitis of extensor pollicis brevis muscle, abductor pollicis longus muscle).

ULNT 3 Main components of external rotation and shoulder joint abduction, elbow joint flexion – ulnar nerve (in the case of carpal tunnel syndrome, epicondylitis of the medial humeri, thoracic outlet syndrome).

VAS Visual analogue scale quantification of pain from 0 to 10.

Walking 1–6km/h.

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