Rehabilitation of Sports Injuries

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13.1 Introduction

Due to the professionalization as well as the enormous public interest, rehabilitation after sports injuries has undergone dramatic changes. This affects the basic conception, the size and composition of the responsible medical departments and rehabilitation facilities as well as the technical possibilities of therapy and training equipment. Until the early 1980s, only the team doctor and masseurs were members of the medical team in sports. However, physiotherapists and osteopaths increasingly developed their interest in the care and the rehabilitation of injured athletes. Likewise, in some countries, with the introduction of professional leagues in various sports, legal requirements have led to the structuring of the rehabilitation of professional athletes after injuries. This ensures appropriate physical preparation for the sport-specific loads. For this purpose, the importance and integration of medical training therapy was initiated and integrated. Specially qualified rehabilitation trainers with scientific training became members of the therapy teams. Currently, it is quite common in football for top clubs to have 15–25 people of various professions in the "care network" of a professional team. These changes and the massive changes and progress in medicine build the basis of modern complex rehabilitation conceptions after sport injuries.

13.2 Biocybernetic Basics of Rehabilitation Conceptions

In general, therapeutic measures in the context of complex rehabilitation strategies should be based on biocybernetic science models. An adequate "therapy control" should pay attention to a corresponding view of the respective measure as purposeful and—in cybernetic sense—controlled influence on biocybernetic control circuits of the organism. Figure 13.1 illustrates the components of therapy control and underlines the importance of clinical performance diagnostics throughout the rehabilitation process. In the course of rehabilitation, evaluation methods of clinical performance diagnostics should be used to check at appropriate intervals whether the respective therapeutic interventions actually led to the expected changes and adaptations of the injured biological structures.

After medical diagnostic information, initial physiotherapeutic examinations and clinical performance diagnostics results are performed at the beginning of rehabilitation, the biocybernetic control process should be structured. This allows an indication-based, individual and

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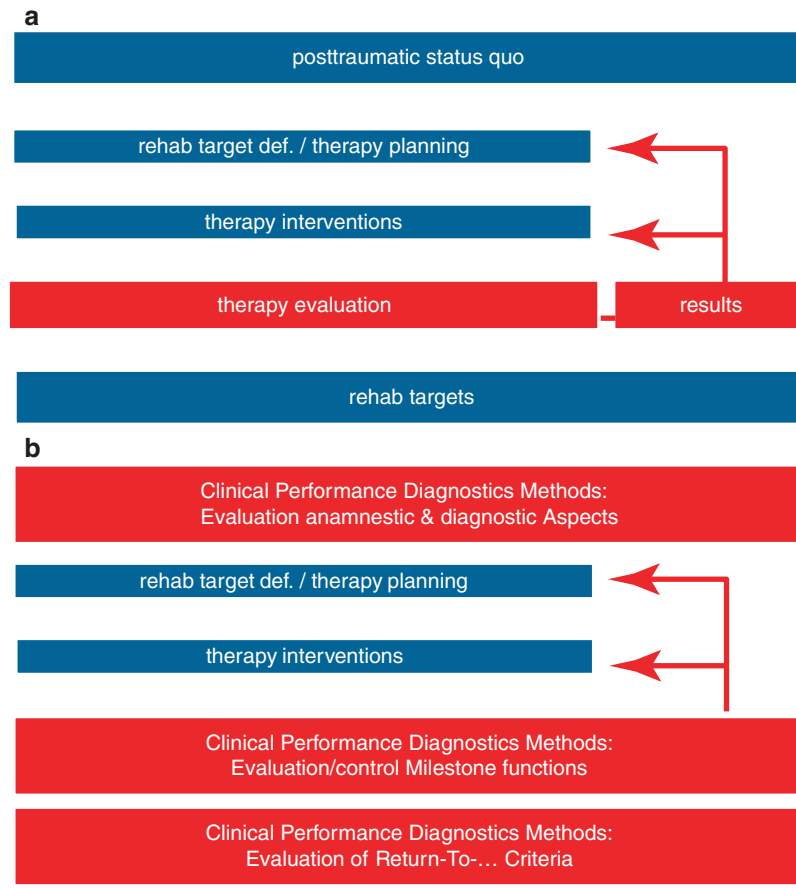

Fig. 13.1 Biocybernetic process components (**a**) and clinical performance diagnostics focus (**b**)

adequate planning and coordination of all therapeutic and training therapeutic interventions. During the therapy process, a timely response in the form of reorganization and new conception of the therapeutic interventions is possible due to the feedback loop, if expected advances in therapy do not occur. Therefore the most time-efficient rehabilitation possible is enabled and ensured. The respective evaluation methods available to the rehabilitation facility can be used throughout the complete rehabilitation process:

1. At the beginning of rehabilitation, the current status quo of the patient is documented to quantify and qualify existing functional and performance-related deficits.
2. During the rehabilitation process, the actual status of the respective functions criteria of the respective current rehabilitation milestones will be evaluated and documented.
3. At the end of the rehabilitation before the reintegration into the team training the sport-specific return-to-sport criteria are checked.

In conclusion, complex rehabilitation strategies should organize their therapeutic interventions according to the principles and regulating biocybernetic control circuits.

13.3 Therapeutical Interventions

13.3.1 Sport-Specific Adaptation Profile

As part of the rehabilitation after sports injuries, there are necessary indication-specific therapeutic interventions. However, potential changes in the musculoskeletal system of the injured athlete due to medium and long-term adaptations of the musculoskeletal system must

also be considered and taken into account. This applies particularly in sports that provoke adaptations of the various biological structures of the musculoskeletal system in the context of repetitive stereotypes with recurring asymmetrical or lateral mechanical loads. In these cases a sport specific adaptation profile can be compiled (Fig. 13.2).

All football specific different patterns (sidesteps, forward and backwards running, fast shift

Fig. 13.2 (**a**) Football-specific adaptation profile. (**b**) Hockey-specific adaptation profile. (**c**) Tennis-specific adaptation profile

in directions, leg alignment and core stability in duel, jumps and landing, quick start and stop movements, etc.) lead to responses in specific biological structures undergoing adaptions that enable the athlete to adequately recall the movements after having trained and repeated these for a long time. These transformations concern muscles, ligaments, bones and myofascial structures and are normally not distributed in a symmetric way: a dominant kicking and non-dominant standing leg. These facts are important in rehabilitation settings where it is important to consider whether the adaptive changes should be prophylactically "treated" and reversed, or at least limited, with the goal of preventing future degenerative problems.

A large number of ball contacts are repeated over a long period of time, which may be measured in years. This creates stimuli that act as repetitive microtrauma and will eventually evoke changes by contact of the kicking leg with the ball in the musculoskeletal system:

- Radiographically visible bone changes were noted only on the kicking-leg side of professional football players who had been playing for at least 3 years.
- Kicking balls with a faulty, biologically unfavorable technique will quickly increase the tensile stresses on the talonavicular ligament to unphysiologically high levels that may exceed stress tolerance, resulting in an acute injury.

From a biomechanical point of view, the kicking movement of the leg is an "open kinetic chain" action in which the foot is moved at maximum forward speed (moving point) while the hip is relatively stationary (fixed point). At the same time, every kicking movement will impose a "closed kinetic chain" type of load on the non-kicking side. In this case the foot is planted on the ground (fixed point) while the overlying structures of the pelvic-leg axis and torso are in motion (moving point) and must therefore be stabilized against gravity through complex coordination.

Musculoskeletal adaptation through asymmetrical muscular changes with significant muscular differences between the standing leg and kicking leg in football players are described. Shooting the ball is a multiple-joint movement in which an (apparently) explosive extension of the knee is combined with active flexion of the hip and extension (plantar flexion) of the foot at the ankle joint. An increased maximum strength capacity and striking force of quadriceps muscle contraction during extension on the kicking-leg side, accompanied by an increased maximum strength and striking force of the knee flexors on the support side is described (quadriceps stronger on the kicking side, hamstrings stronger on the support side, varying in different playing positions according to the requirements of those positions).

To permit successful ball acceleration by the kicking leg with effective momentum transfer to the ball, the support leg must be planted next to the ball on the ground. The following standing leg changes caused by kicking technique are important in this regard:

- Football players plant their standing leg next to the ball with remarkable consistency and precision (inter-individual differences are less than 1 cm!).
- As the foot is planted on the ground, the body center of gravity shifts outward toward the support leg, usually moving past the left knee or even farther laterally.
- Individual movement patterns are carried out with great precision (intra-individual consistency): the farther the standing leg is placed from the ball, the greater the lateral shift of the body center of gravity. The joints along the left pelvic-leg axis must stabilize and compensate for this position and adapt to it over time.

The foregoing neurophysiologic changes that occur on the supporting and kicking sides in response to playing stresses also induce long-term changes in the healthy lumbo-pelvic-hip region. The dominance of the powerful quadriceps and hip flexors (especially the iliopsoas muscle) on the kicking side causes adaptations of the pelvic-leg axis**,** so that the pelvis tilts posteri-

orly on that side. This in turn causes an anterior pelvic tilt to develop on the opposite side in an effort to stabilize the body center of gravity. Often these changes are accompanied by a decreased range of motion in the sacroiliac joint on the kicking side. The asymmetrical range of motion, combined with the twisting of the hips, causes an apparent lengthening of the standing-leg axis and leads to functional pelvic obliquity.

13.3.2 Structural Analysis of the Rehabilitation Process

Based on the structural process analysis, an optimized rehabilitation protocol starts with the return to activity period after being discharged from clinical treatment to general rehabilitation training. This means general rehabilitation with various therapeutical interventions is described in detail below. The return to sport describes the phase from the beginning of sport-specific rehabilitation training to reintegration into team training and is realized in the rehabilitation facility and then combined and extended in the club/training ground. Criteria for entering the return to sport phase are given in Fig. 13.3):

Complex rehabilitation strategies have a variety of individual therapeutic interventions. These can initially be divided into three subcategories:

- Measures of physical therapy
- Physiotherapeutic measures (hand-on techniques)
- Measures in the context of medical training therapy

13.3.3 Physical Therapy

The term physical therapy in this context is intended to summarize therapeutic methods based on physical methods (for example heat, cold, light, or electrical stimuli). Since the terms "physical therapy" and "physiotherapy" are used interchangeably in the following, the physical therapy should be regarded as an independent treatment category. The applications are applied by means of different therapy devices. Common classic methods of physical therapy are:

- Treatment with mechanical stimuli (massage)
- Treatment with thermal stimuli (heat and cold)
- Treatment with water (hydrotherapy)
- Treatment with electricity (electrotherapy)

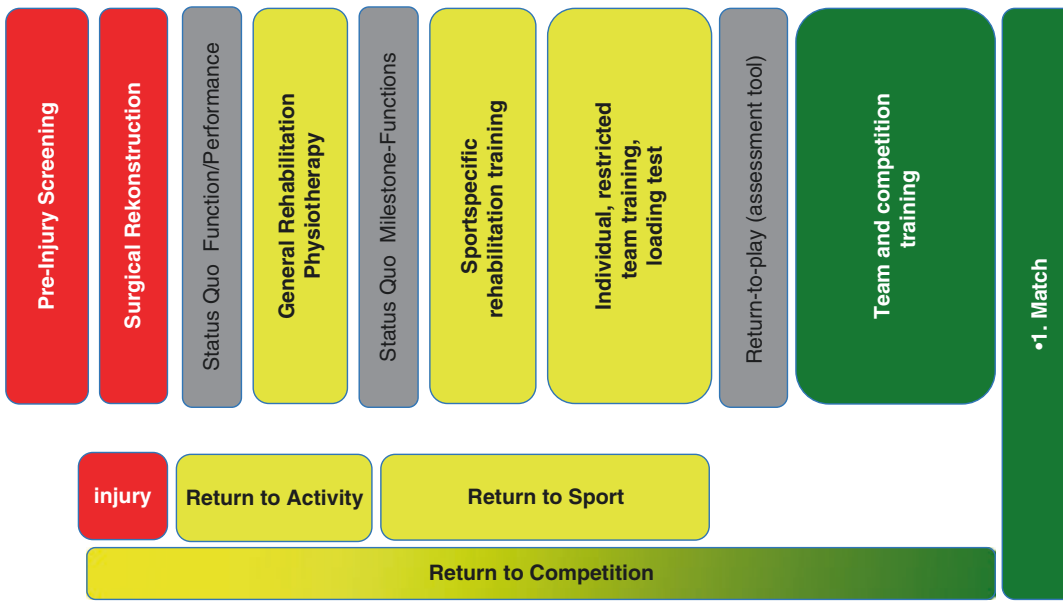

Fig. 13.3 Process analysis of rehabilitation after sport injuries

Technical progress in this area leads to far-reaching changes and additional forms of therapy that are currently being offered. These apparatus therapeutic methods have been significantly expanded, especially in the private practice of physiotherapeutic rehabilitation centers. Physiotherapists now also provide, for example, radial shockwave therapy, therapeutic laser therapy devices, and different types of magnetic therapy. In addition to the sometimes high investment costs, there is little evidence in scientific literature for many of these forms of physical therapy. Nevertheless, the following therapeutic goals can be formulated, for example, for the respective biological (wound) healing phases:

- In the course of the acute inflammatory phase, a general normalization of metabolic physiological processes should be promoted and supported. Pain reduction, limitation of the tendency to swell as well as limitation of inflammatory processes are in the foreground.

  During the following phase of proliferation, the restoration of the functions of the injured structures by means of physiotherapeutic "hands-on" techniques are then in the foreground. Here applications of physical therapy for the preparation and follow-up of manual physiotherapeutic interventions are very well supported;
- The final transfer phase from the proliferation phase to the remodeling phase, in turn, focuses on rehabilitation measures with medical training therapy to restore the performance of the musculoskeletal system. Here measures of physical therapy in the training process both for the preparation (warm-up) as well as in the follow-up for the promotion and initiation of regenerative processes can be used in addition.

13.3.4 Physiotherapy

As a natural healing process, physiotherapy ("hands-on") uses natural adaptation mechanisms of the body to specifically treat disorders of bodily functions or to avoid them in preventative health care. Also in the field of physiotherapeutic applications and techniques, which is used in physiotherapy after sports injuries, great changes have taken place in recent years. In addition to the classical techniques for the restoration of the respective body functions (after sports injuries preferably the techniques of manual therapy for the restoration of joint and muscle functions), the importance of the fasciae and the fascial system in the musculoskeletal and sensomotorical system has been established and propagated appropriate new therapeutic approaches. Thus, for example, the interdependence of structures of the parietal system to the structures of the visceral and craniosacral system in osteopathy has been discussed and has also revealed new findings and therapy techniques for physiotherapy after sports injuries.

Fundamentally, the following general objectives for the respective phases of (wound) healing can thus be formulated:

- In the course of the acute and inflammatory phase, pain reduction and the normalization of metabolic processes are the main focus.
- During the subsequent proliferation phase, the focus is on restoring the respective biological systems involved. The function and load capacity of the musculoskeletal system, the joints and spine and the neuromuscular system should be reached in a timely manner. During the rehabilitation process after sports injuries, the techniques of manual therapy as well as partial aspects of osteopathy have proven themselves in practice.
- The final remodeling phase which focuses on the recovery of the performance of the musculoskeletal system is then dependent on physiotherapeutic techniques for the preservation, control of the optimal functions after training loads in the context of medical training therapy and the medical sports specific training.

13.3.5 Medical Training Therapy

The importance of medical training therapy in the context of complex therapy strategies after sports

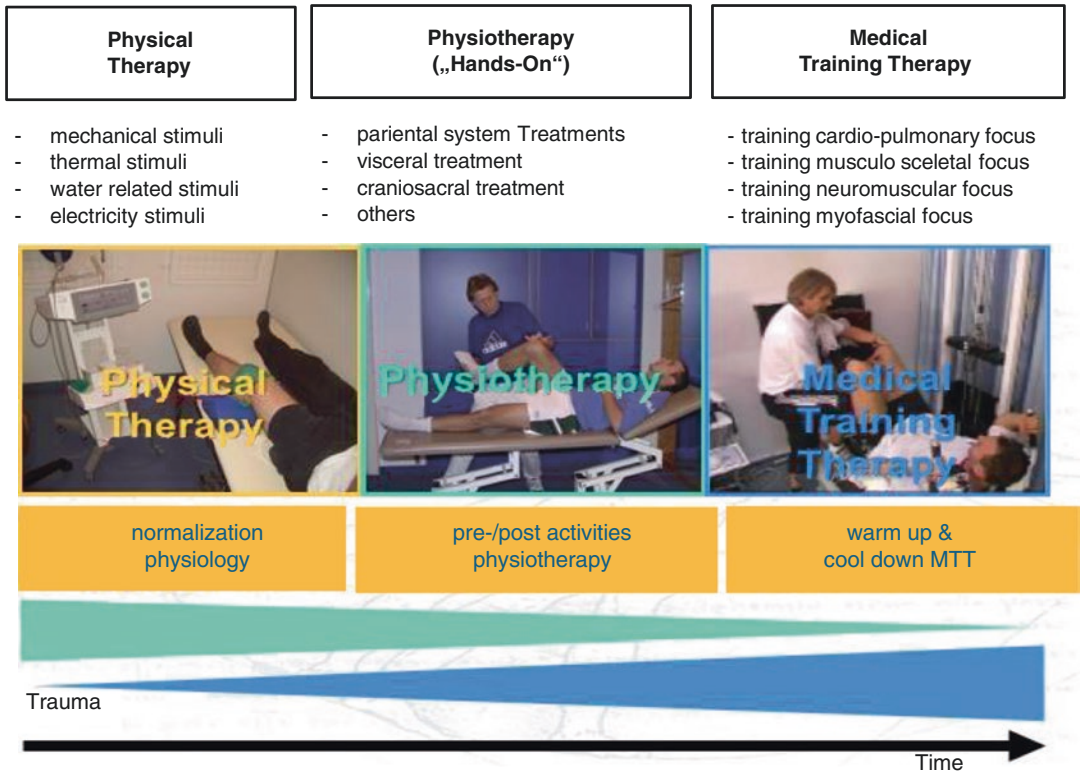

Fig. 13.4 Treatment categories and rehab periodic focus

injuries has gained more and more importance in the 1980s and is now established internationally as well. As an integral part of "sport"-physiotherapy, medical training therapy is now also recognized and accepted in most countries by insurances (Fig. 13.4).

– Medical treatment therapy in the rehabilitation after sports injuries during the acute and inflammatory phase plays a rather subordinate role. Only training measures for the maintenance of a general state of health (possibly also excluding the injured structures) as well as cardiovascular training with the emphasis on the optimization of auto-repair metabolic processes are recommended.
– In the course of the proliferation phase, the focus is on training measures to restore the function of the injured structures by means of endurance training to promote the cardiopulmonary supply situation of the musculoskeletal system. In the context of muscular rehabilitation, the focus is on the neuromuscular system for the restoration of joint stability as well as the limitation of musculoskeletal deficits following musculoskeletal disorders.
– In the course of the remodeling phase, the targeted performance of the musculoskeletal system (selective strength training of deficient musculature) as well as neuromuscular training focuses on the intra- /intermuscular restoration of joint or axis stability (lower and/or upper limb) as well as sufficient and adequate core stability. The training target within the remodeling phase should be orientated on sport-specific needs and to prepare a potential partial re-integration into team training.

Due to the number of participating therapists and trainers as well as the rehabilitation-managing doctors and the number of indication-oriented therapy interventions, a daily expenditure of 8 h is not uncommon in rehabilitation after sports injuries. At the same time, communication

problems between the individual involved therapists/trainers are increasingly evident. In addition, despite the same number of therapeutic interventions in comparable injuries, there are often significant differences in outcome. This is undoubtedly due to the different sequences of the respective therapeutic measures, since certain therapeutic measures in combination in a less suitable order can cancel out and/or supplement in their effect. To realize the appropriate and best treatment results of given therapy interventions, optimal communication of all parties is required. At the moment this problem area has not yet been solved sufficiently. Further research should permit continued studies on safety and effectiveness of rehabilitation and is justified.

13.4 Quality Management Strategies: Time-Based vs. Function-Based Rehabilitation

The control of the rehabilitation process after injuries depends on the medical treatment regimen. This is usually based on the respective posttraumatic stress tolerance of the injured biological structures and their regeneration and is a time-based rehabilitation (Fig. 13.5) concept. The focus is on the current load tolerance until the restoration of the mechanical normal load (against gravitation) within the scope of ADL stereotypes. This represents the medical framework for complex rehabilitation concepts. The data are based largely on the findings on the respective biological wound healing processes and the associated time spans, but vary in practice in some cases on a considerable scale. These time-based preconditions are certainly still relevant in the future and cannot be undershot without provoking an increased risk of re-traumatization of the affected biological tissue.

Current concepts of complex therapy control now attempt to describe each individual therapy process by means of functional criteria, taking into account the time-based minimum time spans of the wound healing processes. These represent in each case the sufficient features to initiate the next therapy step. In the optimal case, the respective individual criteria with the corresponding minimum values should be defined and can be determined both qualitatively and quantitatively on the basis of objective evaluation methods as possible.

Taking the time constraints of the wound healing processes into account, function-based rehabilitation concepts (Fig. 13.6) allow for time-optimized progress within the therapy process, since the next rehabilitation step can be initiated at the earliest possible time (in contrast to the time-based concept perhaps during the eighth postoperative week); problems during rehabilitation can be avoided, for example an early start in the 20th week, can be prevented by continued swelling problems. For example, running loads with one-legged support phases can be determined using the methods shown in Fig. 13.6).

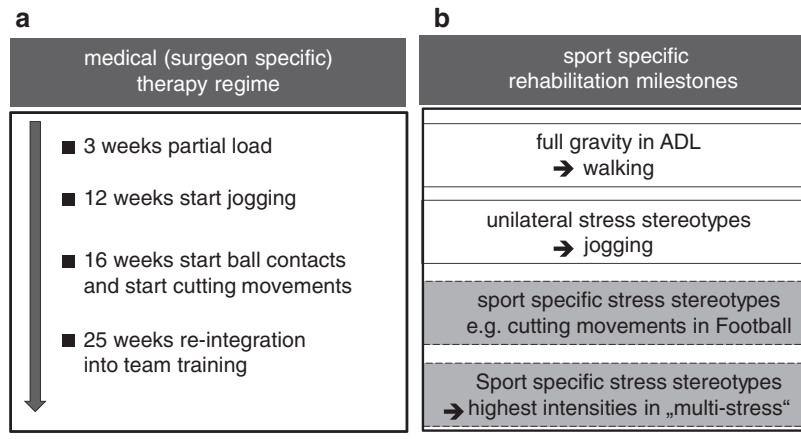

Fig. 13.5 Time-based therapy regime (**a**) and rehabilitation milestones (**b**)

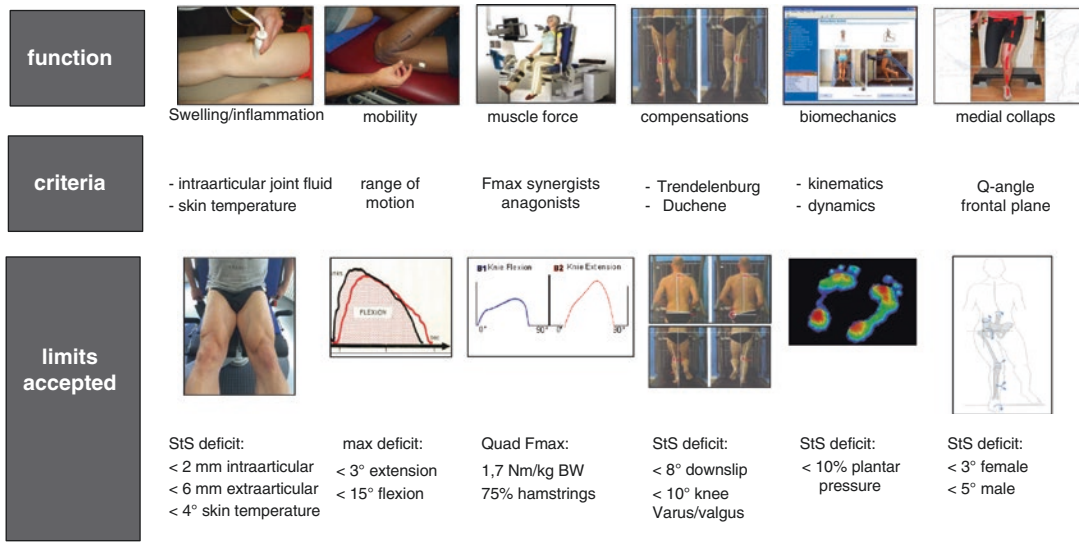

Fig. 13.6 Overview functions from milestone "linear jogging"

Exemplarily illustrated parameters can be checked objectively. An appropriate test procedure should be assigned to each criterion and the minimum quantitative expression defined.

13.5 Pitfalls

- Successful rehabilitation after sports injuries needs as fundament an individual and indication-specific compilation of therapeutic goals and the associated sum of all therapeutic interventions, as well as the attention of sport-specific adaptations. Thus, the post-traumatic manifestations of the respective changes are visible and allow any necessary interventions with the appropriate intended changes (somatic dysfunction). A disregard of the sport- and discipline specific-adaptations can usually lead to missing functional or inadequate therapeutic strategies.
- As part of sports physiotherapy, the expectations of patients (injured athletes) and their environment (trainers, managers, press, etc.) creates a constant pressure of time. A complete restoration of the patient's function and performance in the fastest possible time is expected. This requires that often the minimum requirements of the biological wound healing processes are disregarded. As consequence of time, pressure exhibits a risk to potential re-traumatization within the framework of the rehabilitation process.
- Lack of communication among the physicians, therapists, and trainers involved in the rehabilitation process and other members of the therapy team is one of the main reasons for inefficient and prolonged rehabilitation after sports injuries and prevents an optimized temporal, individual, and indication-specific sequence of the respective therapeutic interventions. This leads frequently to inadequate and unintended therapeutic effects due to effect overlays and therapeutic interdependencies and delays the rehabilitation process.

13.6 Fact Box

- Complex rehabilitation strategies/concepts should understand and organize their therapeutic interventions/therapies according to the principles of regulating bio-cybernetic control circuits.
- Therapy goals in the context of rehabilitation after sports injuries should be based on sport-specific requirement profiles and consider sport-specific adaptations.
- The rehabilitation after sports injuries requires an adequate indication-specific and individual

interdisciplinary implementation and implementation of all necessary and appropriate therapeutic interventions/treatments of physical therapy, physiotherapy, and medical training therapy.

- In addition to the selection and the number of adequate therapeutic measures, the rehabilitation result is particularly dependent on an adequate sequence and coordination of the individual measures and requires intensive coordination and communication between the therapists involved.
- In order to ensure the earliest possible rehabilitation/return-to-sport after sports injuries, an assessment of the current functional and performance status of the injured athlete is required, in addition to the consideration of biological healing phases under time-based aspects.
- For this purpose, milestones can be assigned to the indication-specific rehabilitation processes by defining verifiable functions (in the sense of minimum qualifications), the achievement of which allows the earliest possible individual- and indication-specific selection of necessary and suitable therapeutic measures.

Recommended References

1. Eder K, Hoffmann H (2010) Physikalische und physiotherapeutische Maßnahmen und Rehabilitation. In: Müller-Wohlfahrt H-W, Überacker P, Hensel L (eds) Muskelverletzungen im Sport. Georg Thieme Verlag, Stuttgart/New York, pp 313–321
2. Bloch H et al (2015) Return to competition—VBG Consensus Statement. Verwaltungsberufsgenossenschaft. http://www.vbg.de/SharedDocs/MedienCenter/DE/Faltblatt/Pressemeldungen/151117_PM_Return-to-Competition.pdf?_blob=publicationFile&v=1. Accessed 29 Jan 2017
3. Eder K, Hoffmann H (2016) Verletzungen im Fußball: Vermeiden—Behandeln—Therapieren. Elsevier GmbH, München
4. Hoffmann H, Krutsch W, Loose O (2018) Principles and limitations of prehab and RTP strategies. In: Mushal V, Karlsson J, Krutsch W, Mandelbaum BR, Espreguera-Mendes J, d'Hooghe P (eds) Return to play in football: an evidenced based approach. Springer, Berlin, pp 111–125
5. Robert V (2019) Ist asymetrie dysfunktion? Osteopathische Medizin 20(Suppl 1):4–8
6. Marquart M (2012) Laufen und Laufanalyse. Thieme Verlag, Stuttgart/New York