

Clinical Commentary/Current Concept Review

Physiotherapy and Exercise Therapy after Surgical Treatment of Femoroacetabular Impingement Syndrome: A Clinical Commentary from the QKG – Society for Cartilage Regeneration and Joint Preservation

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There are many approaches to physiotherapy and exercise-based rehabilitation following surgical treatment of femoroacetabular impingement syndrome (FAIS). Focus on a multidimensional approach, integrating tissue healing timelines with patient-specific functional recovery strategies is important. Key surgical considerations, such as labral- and/or capsular management and cartilage regeneration, alongside their implications for postoperative rehabilitation must be considered. The purpose of this clinical commentary by the Society for Cartilage Regeneration and Joint Preservation (QKG) is to provide a comprehensive framework for the physiotherapy and exercise-based rehabilitation following surgical treatment of FAIS. The framework outlines distinct time- and criteria-based phases of rehabilitation, from preoperative preparation (prehabilitation) to long-term recovery, emphasizing an individualized assessment and care, supported by recent research linking musculoskeletal outcomes to psychosocial drivers, emphasizing the need for personalized rehabilitation strategies.

Level of evidence

5

INTRODUCTION

Femoroacetabular impingement syndrome (FAIS) is one of the most common causes of pain and functional limitations in young to middle-aged hip patients.¹ The symptoms are attributed to premature contact between the femoral neck and the acetabulum. The main causes of this are bony bulges with resulting tailing disorders at the femoral-neck-head transition (cam morphology) or an excessive coverage of the femoral head by the acetabulum (pincer morphology).^{2,3} This is exacerbated by abnormal femoral and acetabular version, as well as abnormal movement-related kinematics of those affected.^{4,5} If conservative treatment has failed and the patient continues to have symptoms or dysfunction, surgery may be the treatment of choice. It is therefore not surprising that the number of hip arthroscopies in this patient group has increased steadily over the last decade.^{6,7} Previous reviews of postoperative exer-

cise rehabilitation have examined different aspects of recovery. Hemstock et al.⁸ focused on weight-bearing and range of motion recommendations.⁸ Meanwhile, Takla et al.,⁹ Holling et al.¹⁰ and Hanish et al.¹¹ proposed time-based rehabilitation protocols alongside general postoperative guidelines.⁹⁻¹¹ However, these consensus statements and reviews lacked detailed descriptions of possible exercise parameters and progressions for individual muscle groups. Furthermore, a detailed description of impairment- and activity-based performance tests with benchmark values are needed to optimize rehabilitation. While existing studies provide a general framework, they do not offer practical guidance for clinicians. This clinical commentary by the Society for Cartilage Regeneration and Joint Preservation (QKG) seeks to provide a comprehensive framework for the physiotherapy and exercise-based rehabilitation following surgical treatment of femoroacetabular impingement syndrome (FAIS).

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Table 1. Possible limitations in the acute postoperative phase – early proliferation^{8,11-15}

Affected structure	Limitation (weight bearing or ROM)	Time frame
Cartilage	15-20 kg restrictive weight bearing	6 weeks
Capsule	Flexion: $\leq 90^\circ$ Extension: 0° Abduction: $\leq 45^\circ$ External rotation: $\leq 20^\circ$	3 weeks
Labrum		
Bone (femoral)	15-20kg restrictive weight bearing	3-4 weeks

It comprises the experiences and convictions of the physiotherapists and orthopaedic surgeons of the QKG and is also based on a narrative synthesis of the current literature.

TISSUE HEALING AND WEIGHT BEARING/ROM RESTRICTIONS

The healing of the addressed structures following the individual procedures (cartilage regeneration procedures, femoroplasty, acetabuloplasty, labral repair, reconstruction, capsuloplasty) exerts a significant influence on the timing and content of the rehabilitation process and forms the basis for certain movement limitations.

REHABILITATION

BIOPSYCHOSOCIAL FRAMEWORK

The treatment of patients with hip pain should not follow a one-dimensional biomedical perspective. Musculoskeletal complaints are regarded as complex, biopsychosocial phenomena, that are perpetuated by different multidimensional drivers. The revised American Physical Therapy Association Guideline by Ensek et al.¹⁶ recommends an International Classification of Functioning, Disability and Health (ICF) based rehabilitation model addressing impairments of body function and structure, activity limitations and participation restrictions in those with nonarthritic hip joint pain.¹⁶

Beck et al.¹⁷ and Perez et al.¹⁸ found a significant influence of sensitization processes in the central nervous system (Central Sensitization Inventory Scores (CSI)) on postoperative outcomes.^{17,18} Rhon et al.¹⁹ showed an increase in concomitant diseases (e.g. mental health disorders, chronic pain, cardiovascular disorders) after hip arthroscopy.¹⁹ Finally, psychosocial, such as kinesiophobia or catastrophizing, and contextual factors (e.g. the health care system or the therapeutic alliance) exert a significant influence on postoperative outcomes.^{20,21} According to Jochimsen et al.²² the odds of having elevated post-operative pain at rest were 45 times and 4.5 times higher for those with low self-efficacy and high pain catastrophizing ($p \leq 0.03$), respectively.²² Consequently, clinicians are advised to use patient-reported outcome measures (PROMs) to assess for depression, anxiety (i.e. EQ-5D anxiety/depression dimension), low self-efficacy (i.e. Pain Self-Effi-

cacy Questionnaire), and kinesiophobia (i.e. Tampa Scale of Kinesiophobia) at baseline and at least one other follow-up point that includes discharge in those with nonarthritic hip joint pain.^{16,23} Patients with persistent hip pain often show unfavorable beliefs about “damaged” hip structures, which can lead to avoidance behavior, overprotective movement patterns and a significantly reduced quality of life (distress, sleep disturbances, etc.).²⁴ In a holistic understanding, these complex factors should be understood as cognitive or behavioral barriers to an active therapy approach or a long-term favorable outcome and should be addressed accordingly in postoperative rehabilitation.^{21,25-27}

Using a psychologically informed practice model, musculoskeletal rehabilitation clinicians can integrate psychological and mind-body techniques—such as SMART (Specific, Measurable, Attainable, Relevant, Time-bound) goal setting, diaphragmatic breathing, pain science education, basic cognitive restructuring, mindful pain awareness, and progressive muscle relaxation—into traditional exercise-based programs in an individualized patient-centered approach.²⁸

A PHASED MODEL

Movement-based rehabilitation after surgical procedures is based on a tissue healing framework (see [Table 1](#)), the measured individual impairments and the individual progress of those affected. It has therefore become common practice to structure the recommendations within a rough tissue-specific timetable.^{11,15,26} According to Kaplan et al.,²⁷ there is a continuous improvement in PROMs in the first six months.²⁷ According to their data, postoperative treatment should therefore be planned for at least six months and longer time frames should be considered, especially for patients receiving cartilage regeneration procedures. A home program might be equally effective as a treatment under constant supervision and is able to potentiate the effects of clinically based treatments.^{29,30} However exercise programs that are carried out independently should be supervised and adapted to a certain degree. Ideally, sufficient preoperative preparation should be implemented before surgery.²⁶ A phase model combines connective tissue healing times with the principles of sports science and is the preferred model of the QKG.

PREHABILITATIVE PHASE (PREHAB)

Patients with FAIS exhibit functional (strength) and structural (atrophy and fat infiltration of muscle) contributions

to movement impairments that may be correlated with poorer postoperative outcomes.^{17,31-34} Therefore, the aim of prehab is to improve functional capacities of those affected to accelerate postoperative recovery.³⁵ All interventions should be adapted to individual needs and person specific goals to meet the demands of patient-centered care.³⁵ While there is evidence for the effectiveness of prehab in other fields (e.g. prior to acl reconstruction), there are no results available for hip arthroscopy - excluding the data from Grant et al.^{36,37} However, in their pilot study, an 8-week home exercise program before surgery showed higher strength values (knee extension and hip flexion) and a better quality of life (EQ-5D-5L) compared to no prehabilitation treatment.

If prehab is used, an active training program should be developed, consisting of motor control exercises (postural control, dynamic control of joint alignment), strengthening of the muscles of the thigh and hip, and general endurance training to maintain aerobic capacity. In addition, the following areas should be addressed within patient education:

- Biomechanical education: Modification of symptomatic movement patterns, such as anterior pelvic tilt or avoiding sitting with high hip flexion and crossed legs, can potentially increase pain-free ROM.³⁸
- Learning how to use crutches safely in everyday life.
- Therapeutic pain education: Information about the expected trajectories of musculoskeletal pain can reduce fear of movement and catastrophizing thoughts in the postoperative phase.³⁹
- Behavioral therapy elements: Emotional reactions after trauma/surgical procedure exert a significant impact on postoperative rehabilitation outcomes. Fear of movement, catastrophizing and low self-efficacy should therefore be identified and addressed early on.^{20,40-42} In therapeutic communication, care should be taken to ensure that patients are not further worried by a strong focus on maladaptive biomedical illness perceptions.^{24,43}
- Modification of lifestyle factors: Smoking, obesity and reduced sleep quality are predictors of poor postoperative pain control or outcome.^{44,45}
- Expectations: Expectations are a significant factor influencing postoperative outcomes.^{46,47} Individually adapted, realistic and relevant goals should therefore be formulated.

ACUTE POSTOPERATIVE PHASE (0-2 WEEKS)

During the first two weeks, the focus is on protecting the healing structures and on controlling the inflammatory reaction. For this purpose, the restrictions in [Table 1](#) may apply, depending on the surgical procedure.

To ensure safe and protected ROM, 40% and 48% of surgeons respectively recommend the use of hip braces.^{8,48} Braces can effectively reduce ROM in flexion.⁴⁹ However, the clinical benefit seems to be minor at best. Fischer et al.⁵⁰ showed a reduction in fear of movement as a result of hip bracing. However, the clinical impact cannot yet be assessed due to the lack of data. Others only found less pain

and a better quality of life in men (VR-12-MCS). Due to the low statistical power, Wentzel et al.⁵¹ cast doubt on the clinical relevance of their results. Even more importantly, however, complications or recurrent interventions were not prevented by hip bracing in any of the studies. The protective effects therefore seem to be neglectable.^{50,51} Considering the higher costs, hip braces should not be prescribed routinely, but only in individual cases according to the authors opinion.

Restrictive weight-bearing is reserved for patients who have undergone cartilage regeneration procedures or extensive femoroplasty/CAM correction ([Table 1](#)). Otherwise, early weight bearing as tolerated does not seem to cause any disadvantages.^{8,52-54} It should be noted that joint reaction forces in the hip joint are determined less by ground reaction forces than by muscle forces crossing the joint.⁵⁵ This fact becomes particularly evident when considering the magnitude of joint reaction forces in non-weight-bearing exercises ([Table 2](#)).⁵⁵⁻⁵⁷ Therefore, to reduce joint forces, muscle contraction intensities must be considered; a sole focus on weight-bearing is biomechanically implausible and is currently not recommended.⁵⁸

Early mobilization is uniformly recommended for the purpose of nourishing the cartilage regenerate (in the case of cartilage regeneration procedures) and preventing adhesions.^{11,59,60} Philippon et al.⁵⁹ initially start with passive mobilization techniques (continuous passive motion (CPM), manual circumduction, [Table 3](#)) and supplement the program with active automobilization (e.g. bicycle ergometer taking use caution with saddle height/crank length adjustment with low resistance or movement in water).⁵⁹ The exact parameters for the mobilization techniques used have not been published. The Tissue Regeneration Working Group of the German Society for Orthopaedics and Trauma Surgery (DGOU) recommends CPM for three hours over six weeks after knee joint surgery.⁶¹ Philippon et al.,⁵⁹ on the other hand, recommend 4-8h a day.⁵⁹ A randomized controlled trial by Munsch et al.⁶² including 54 patients who underwent arthroscopic acetabular labral repair reported a statistically significant decrease in pain levels in patients using CPM 4-6 hours daily throughout the first two postoperative weeks compared to patients in the control group (no CPM).⁶² Further studies are needed to evaluate the benefits of CPM especially in cases of hip arthroscopy in conjunction with cartilage repair techniques.⁶³

Due to the low primary stability in cartilage regenerative procedures, strength- and hypertrophy-oriented resistance training for the muscles surrounding the hip is due to the high mechanical stress not possible in this phase. However, for the prevention of muscle atrophy and the early treatment of arthrogenic muscle inhibition (AMI), strength training on the healthy side (cross-education), neuromuscular electrical stimulation or mental training can be used ([Table 4](#)).⁶⁴⁻⁷⁰

General aerobic endurance training using an upper body ergometer can reduce lower limb pain, maintain fitness and improve results in patient reported outcome measures.⁷¹⁻⁷⁴ In addition they exhibit an anti-inflammatory effect.^{75,76} Unfortunately, the available studies refer to the treatment

Table 2. Resulting compressive joint reaction force during exercises/movements without weight bearing⁵⁵⁻⁵⁷

Intervention of movement	Compressive joint reaction force (in % of body weight)
Stretching of the rectus femoris	179%
Hip abduction on the cable pulley (10kg resistance on the free moving leg)	167%
Hip abduction in long sitting against TheraBand	245%
Isometric contraction in supine position (different levels)	50-230%
Breaststroke	193%

Table 3. Parameters for passive early mobilization⁵⁹

Parameter	Continuous passive motion	Passive circumduction
Intensity	Pain and tension free (NRS 0-2)	
ROM	Week 1: 10-45° flexion Week 2: 0-60° flexion Week 3: 0-70° flexion From week 4: 0-80° flexion	Small circular movements (approx. 20-25cm) in 60-70° hip and knee flexion
Duration	4-8 hours per day for 4-8 weeks (labral cartilage regeneration procedures)	60 repetitions, 3-4 times a day for 10 weeks

Table 4. Possible exercise parameters in postoperative acute phase⁶⁴⁻⁷⁰

	Cross Education	Mental training (motor imagery)	Neuromuscular electrical stimulation
Device	Resistance machines	-	NMES device
Intensity	High, ≥80% of maximal strength	Maximum, 100%	Visible, palpable contraction, RPE 8/10
Repetitions	6-12	25	15 reps of 10 seconds on, 30 seconds off
Sets, rest between sets	3, 2 minutes	2-3	1
Frequency per week	2-3x	3x	Daily, 2-3x
Duration	8 weeks	4 weeks	6 weeks

of patients with knee pain or patients preparing for knee and hip replacement surgery. No data is available in post-operative hip rehabilitation. However, in view of the favourable metabolic, neuroimmune and cardiovascular effects, the authors recommend supplementary aerobic endurance training.

All supervised exercises should be performed with low pain ("green pain light" <3/10 NRS) and only be carried out when the tissue irritation level is adequate. Regression of the exercises and passive modalities (e.g. cryotherapy) are indicated in cases of high irritability.

EARLY PROLIFERATION PHASE (UP TO ABOUT 6 WEEKS)

In this second phase, partial weight-bearing requirements continue to dominate in cartilage regeneration procedures, so mobilization of the hip plays an essential role. In this context, it is important to note that achieving full hip mobility (compared to the unaffected side) is not realistic.⁷⁷ Even after a mean follow-up of 31,3 months in goniometric measurements, the improvement varies significantly

(0.1-12.2° in flexion, 3.6°-21.9° in internal rotation and -2.6-12.8° in external rotation). It can therefore be assumed that other factors are limiting postoperative ROM than a mechanical block to movement from abnormal bony morphology of the proximal femur and/or acetabulum.⁷⁷

In addition to mobilization, patients with FAIS show abnormal movement strategies in everyday activities (e.g. walking or squatting). These motor control changes correlate with PROMs and cartilage health.⁷⁸⁻⁸⁰ Surgical interventions alone do not lead to a sufficient improvement in movement behavior.^{79,81} The improvement of movement quality in general as well as gait and walking speed should therefore be given high priority.

Due to the intraoperative trauma and the concern about instability of the hip joint, joint stabilizing exercise interventions should be started as soon as possible. From the results of basic biomechanical research, it can be deduced that all hip muscle groups possess an important function for joint stability.⁸²⁻⁸⁶ The anterior muscular stabilizers (iliopsoas and iliocapsularis) are considered to play a key role as antagonists to counteract anterior shear forces.^{84,87-89}

Table 5. Required active ROM (peak values) in different planes of motion during everyday activities⁹¹

Activity/Direction of Movement	Flexion-Extension	Abduction-Adduction	Internal-External Rotation
Walking	57.5° - 19.6°	21.6° - 9.18°	14.9° - 12.4°
Step down	39.96° - 1.6°	5.4° - 9.4°	6.05° - 20.2°
Step up	67.07° - 3.55°	4.9° - 10.59°	5.59° - 9.27°
Full squat	121.30° - 11.2°	29.5° - 22.4°	18.7° - 31.6°

Therefore, they should be integrated into the exercise program early on, but in accordance with the corresponding tissue irritability level. In principle, it is recommended to start muscle activation with static contractions of low to moderate intensity in a medium joint position (see progressions in Appendix 1).⁹⁰ In addition to the muscles covering the hip from all sides, exercises for the abdominal and back muscles should be integrated due to their postural influence on the pelvis.⁹⁰

LATE PROLIFERATION PHASE (UP TO ABOUT 12 WEEKS)

Full weight bearing and the individual's full ROM should be achieved by this stage at the latest. Walking without crutches should be permitted if the pain level is adequate (<3/10 NRS), movement quality is sufficient (no limping) and if the available ROM is appropriate. Of note one-dimensional activities of daily living require relatively large ranges of motion in several planes (Table 5).⁹¹ In addition, some limitations contradict each other considerably, such as the requirements for a "normal gait" are incompatible with a required limited range of motion. Limitations must therefore be adapted sensibly and suitably to the functional goals.

The strength of the hip muscles is reduced in the first few weeks due to surgical intervention. After three months postoperatively, the knee and hip flexors strength levels, as well as those of the hip abductors and external rotators, are usually below the preoperative level.⁹² Even after six months, Servant et al. found significant deficits in the strength of the external rotators of the hip.⁹³ Compared to healthy individuals, reduced strength values in the hip flexors and extensors are still present after twelve months, so normalization of the strength values often occurs later.^{94,95}

For these reasons, structured strength training should be started early, depending on the individual's loading tolerance (see progressions in Appendix 1). This can be started using methods that produce favorable neuromuscular adaptation with low mechanical loading of the hip joint. Regarding hypertrophy effects, exercise intensities of around 30% of the individual's maximal strength performance show comparable effects to high load interventions, provided the exercise volume (sets x repetitions x load) is comparable.⁹⁶ The methods of choice would be low load resistance training with or without blood flow restriction (Table 6). To date, there are few studies available for the latter method in hip pathologies. Nevertheless, Hwang et al.⁹⁷ show adaptations even proximal to the applied cuff and Høgholt et al.⁹⁸

emphasize the feasibility in clinical use in patients with greater trochanteric pain syndrome.^{97,98}

Balance and neuromuscular control exercise for joint alignment, as well as gait retraining, complement the exercise program in this phase.

Progression within the proliferation phase should not be based on rigid time parameters but should be adapted to each individual's impairments and competence in performance. In this context, Martin et al.¹⁰¹ recommended test procedures that assess performance and load the hip joint at different intensities.¹⁰¹ In this phase, tests with low and medium intensity are particularly important (Appendix 1 and 2):

- Strength: Five times sit to stand test (5TSTS)
- Balance: One-leg stance test with eyes open and closed (OLS)
- Walking speed: Self-selected walking speed (SSWS, 20 meters)

Normal/good performance can be found in Table 7.

REMODELING PHASE (12TH-26TH WEEK)

In the remodeling phase, the focus is on the development of different strength qualities and dynamic movement patterns.

In the context of strength training, linear periodization models have proven to be effective in the rehabilitation of musculoskeletal disorders.¹⁰⁴ The external load is gradually increased over months, while the exercise volume decreases. This assures progressive increases in load without jeopardizing the cartilage graft in cartilage regeneration procedures. According to the position statement of the ACSM (American College of Sports Medicine) the majority of the training is devoted to the 6-12 repetition maximum for muscle hypertrophy and should be performed at intensities of 80-100% of the 1 RM for increasing maximum strength. An increase in weight of 2-10% should be considered when the current workload can be performed for 1-2 repetitions over the desired number on two consecutive training sessions.

The activation of the key muscle groups in the individual movement planes has been the subject of various studies in the past.¹⁰⁵⁻¹¹¹ Accordingly, for high-intensity exercise interventions, single-leg loading in the frontal plane for the hip abductors, the "Copenhagen adduction exercise" for the hip adductors, step-up or split squat variations for the hip extensors and the "Active Straight Leg Raise" for the hip flexors can be recommended (Progressions provided

Table 6. Exercise parameters for low load interventions^{99,100}

Parameters/Methods	Low Load Resistance Training	Blood flow Restriction training
Exercise	Knee, hip extension, hip abduction, leg press, bridging	
Intensity	30% of maximal strength	20-40% of maximal strength
Repetitions	>30-40	30-15-15-15
Sets, rest between sets	3, 1-2 minutes	4, 30-60 sec.
Frequency per week	3x	2-3x
Duration	10 weeks	≥6 weeks

Table 7. Low and medium intensity tests (Appendix 1 and 2)^{80,102,103}

5TSTS		OLS	SSWS (20 meters)
Age	Mean (CI 95%)	- open eyes: 45 seconds - closed eyes: 30 seconds	→1.5m/s
14-19	6.5±1.2 (6-7) sec.		
20-29	6±1.4 (5.6-6.5) sec.		
30-39	6.1±1.4 (5.5-6.8) sec.		
40-49	7.6±1.8 (6.6-8.6) sec.		

in Appendix 1).¹⁰⁵⁻¹⁰⁹ The short rotators of the hip joint are activated to the greatest extent by a combination of hip rotation and hip extension, such as in the “prone heel squeeze”.^{110,111}

Dynamic movement patterns (walking, running, jumping, changing direction) are particularly important for athletically ambitious patients and should be trained according to the principles of motor learning.^{112,113}

- Training of various movement strategies based on the principle of differential learning. This strategy aims to expose patients to as many different combinations within a class of skills (walking, jumping, running, etc.) as possible.
- Using explicit feedback during movement execution (emphasizing external feedback, i.e. to decrease knee valgus in single leg squat the instruction to “reach towards the cone with your knee is given”).
- Consideration of patient preference when selecting exercises (self-controlled learning, i.e. freedom of choice in selection, level of difficulty, sequence of exercises or self-controlled feedback).
- Enhancing expectancies i.e. by providing positive feedback about patients performance or positive (“this performance is greater than the average”) compared to negative (“below the average”) social-comparative feedback.

Reynolds et al.¹¹⁴ and Kraeutler et al.¹¹⁵ propose a structured framework for recreational runners regarding a return to running program after hip arthroscopy that integrates both clinical and exercise methodological aspects (Table 8).^{114,115} In sports with a high proportion of acceleration and deceleration forces, the program should be expanded to include intensive plyometric loads.

To objectify the treatment process, performance tests with medium-high load loading and PROMs should be used

during/after this phase (Appendix 1 and 2). These values are often regarded as functional milestones for unrestricted participation in sports^{27,101,116}:

- Strength Assessment: Maximal strength testing using handheld dynamometry or isokinetics
- Balance Assessment: Mod. Star Excursion Balance Test (mSEBT)
- Assessment of dynamic control: Medial and lateral triple hop test (MTHT, LTHT)
- PROMS: Copenhagen Hip and Groin Outcome Score (HAGOS), Patient-Reported Outcome Measure Information System (PROMIS), Modified Harris Hip Score (mHHS), Hip Outcome Score ADL/Sport (HOS-ADL/SS), short version of the Hip Outcome Tool (iHOT-12), Hip-Return-to-Sport after Injury Scale short and long version (H-RSI). The threshold values of the clinical scores shown in table 9 were determined at a certain time point and for specific cohorts (PROMS: 2-year postoperative, labral repair/debridement + acetabuloplasty/femoroplasty). Therefore, they cannot be applied across the board to all patient groups and are only exemplary.

Normal/good performance values can be seen in Table 9. Please bear in mind that general standard values do not necessarily correspond to specializations in sports.

MATURATION PHASE (>26TH WEEK)

The final phase is aimed at regaining sport-specific skills and, depending on individual goals, enabling participation in physical activities. For professional athletes, success is often defined by a return to play to pre-injury level, while for recreational athletes, success is also designated by achieving clinically relevant improvements in patient-reported outcome measures.¹²³ However, the timing and pos-

Table 8. Return to Running program^{114,115}

Parameters	Recommendation
Inception (time)	→3 month: labral surgery + femoral/ acetabuloplasty →4.5 months: cartilage regeneration procedures
Start (function/clinic)	• Pain: <3/10 (NRS) during exercise • Good movement quality when stepping down • Adequate performance in low intensity tests (see Table 7) • 30 minutes walking possible
Progression	Goal: 1.5km • Week 1: 75% walking – 25% jogging • Week 2: 50% walking – 50% jogging • Week 3: 25% walking – 75% jogging • Week 4: 100% jogging • >Week 5: Increase distance by 10% per week
Criteria for progression	• Pain: <3/10 during exercise • Symptom worsening <24h • Short-term stiffness of the hip joint <10 minutes • No limping

Table 9. Medium-high loading test, PROMS (Appendix 1 and 2)^{27,95,116-122}

Isometric maximum strength ^T	Single-legged-squat test (SLST) and step-down test (SDT)	Modified Star-excursion balance Test (mSEBT)	Medial or lateral triple hop Test (MTHT, LTHT [‡])	Patient reported outcome measures (PROM-Scores (#))
Extension: >3Nm/kg Flexion: >2Nm/kg Abduction: >2Nm/kg Adduction: >2.5Nm/kg ADD/ABD ratio: 120%:100% Flexion/ Extension ratio: 100%:100% LSI: >90%	Overall impression of test performance as <i>passing</i> and four of the five specific criteria must be negative for deviation. A passing grade on at least one of the three repetitions was needed for the overall evaluation to be graded as passing. Therefore, failing two of the three tests still resulted in passing.	≥95% leg length score <4cm difference in individual directions	MTHT: >390cm LTHT: >340cm LSI: >90%	HOS-ADL: MCID 9.7, PASS 88.2 HOS-SS: MCID 14.3, PASS 76.4 mHHS: MCID 9.2, PASS 83.25 iHot-12: MCID 13.9, PASS 72.2 H-RSI (short version) >65%*/>85%** H-RSI (long version) >60%*/>85%** PROMIS Pain Interference: MCID -4.7, PASS 57 PROMIS Physical Function: MCID 5.8, PASS 45.6 HAGOS-Pain: PASS 69 HAGOS-Symptoms: PASS 63 HAGOS-ADL: PASS 83 -HAGOS-Sport/Rec. PASS 61 -HAGOS-Physical activity: PASS 44 -HAGOS-Quality of life: PASS 43

MCID: minimally clinically important difference PASS: patient accepted symptom state, *first value corresponds to the RTS regardless of level, **corresponds to return to performance or return to preinjury level, #: All MCID or PASS values are validated for the 2-year follow-up.

^T Values for hip extension and hip adduction validated in relation to return to sport and difficulties in specific sports activities; values for hip abduction and hip flexion correspond to mean values + 1 SD

[‡] Values correspond to mean value

sible criteria for a safe navigation on the return continuum have not been well studied in this patient population. In an evaluation of $n=130$ studies, functional criteria are still undervalued, and fixed timeframes dominate the decision-making process. Depending on the sporting requirements, around 70% of athletes return between the third and ninth month postoperatively.¹²⁴ However, these studies often exclude patients who have undergone a cartilage regeneration procedure. In these cases, unrestricted participation is not recommended before the 9th to 12th month.¹³

In addition to the time-based criteria, Hugenberg et al.¹¹⁶ recommended successful completion of a functional test battery regarding mobility, strength, coordination and PROMS for an unrestricted RTS (Table 9).¹¹⁶

On average, 85.4% of athletes successfully return to play (RTP). However, the corresponding pre-injury level is reached less frequently, in 72.6% of cases.¹²⁴ As a limitation, there is currently a lack of specific data on the influence of individual surgical procedures or their combination on RTS rates. The results after hip arthroscopy at the long-term follow-up (127.2 months) can be described as good to very good.¹²⁵ The PASS criteria are achieved in 88.9% of cases for the mHHS and in 80% for the HOS-SS. Poorer results are seen in patients after debridement of the labrum or with a pronounced CAM morphology (alpha angle $>78^\circ$), major femoral cartilage damage $>2\text{cm}^2$, or in those with a greatly reduced joint space at the time of surgery.^{125,126} It is therefore imperative that these factors are given due consideration when formulating a prognosis for the anticipated postoperative outcome.

CONCLUSION

This clinical commentary presented by the QKG – Society for Cartilage Regeneration and Joint Preservation provides a summary, evidence-based framework for rehabilitation following surgical treatment of femoroacetabular impingement syndrome (FAIS). By integrating tissue healing timelines with individualized, criteria-based rehabilitation

phases, the approach aims to achieve optimal recovery by striking a balance between post-surgical protection and functional restoration. The multidimensional biopsychosocial model underscores the importance of addressing not only physical impairments but also psychological, cognitive, and contextual factors that influence outcomes. Tailored interventions, from prehabilitation to long-term recovery, emphasize early mobilization, progressive muscle strengthening, and dynamic movement retraining, guided by patient-specific goals and functional milestones. The commentary highlights the necessity of precise exercise prescriptions aligned with surgical procedures, such as cartilage regeneration, labral repair, or bony corrections, to optimize postoperative outcomes. Ultimately, this framework may support clinicians in delivering patient-centered care, improving patient-reported outcomes, and facilitating a safe return to daily activities or sports, with high rates of athletes achieving return to play, though outcomes vary based on surgical complexity and patient factors. Continued research is needed to refine functional criteria for return to sport and to further elucidate long-term outcomes, particularly for those who have undergone cartilage regeneration procedures.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest

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SUPPLEMENTARY MATERIALS

Appendix 1. QR Code Exercises

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Appendix 2. Assessments

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