

Femoroacetabular impingement in sports medicine: a narrative review

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Abstract

Femoroacetabular impingement (FAI) is a pathomechanical process of the hip, which can occur in every individual but has a higher prevalence in physically active subjects such as athletes. It is mainly due to bony deformities at the proximal femur and/or acetabulum in conjunction with rigorous or supraphysiological hip ranges of motion. FAI may lead to chondrolabral lesions, hip pain and development of early hip osteoarthritis. Symptomatic FAI patients may present functional limitations during daily activities and sports, reduced hip muscle strength as well as hip joint kinematic and kinetic alterations during weight-bearing activities. Hip surgery whether open or arthroscopic is currently the mainstay for the management of symptomatic FAI. It consists of the treatment of FAI-related intra-articular pathologies, such as acetabular labral tears and articular cartilage lesions, and the surgical correction of the underlying bony deformities. Hip surgery demonstrated to reduce hip pain and improve hip function of symptomatic FAI patients in most case series. In addition, relatively high rates of return to sport were reported for FAI athletes after hip surgery. Nevertheless, incomplete recovery of hip muscle strength and hip joint kinematics and kinetics during functional tasks were shown after hip surgery for FAI. Non-surgical treatments aimed at restoring normal hip muscle and physical function have not been considered as a valid alternative to hip surgery for the management of symptomatic FAI so far. Future research should propose standardized physical therapy protocols for the non-surgical management of symptomatic FAI, and investigate their effectiveness in reducing hip pain and improving hip function. In addition, randomized controlled trials should compare surgical with non-surgical treatments for FAI so as to provide knowledge about the optimal conditions and time point for hip surgery.

Keywords: Hip; Pain; Surgery; Return to sport; Physical function; Non-surgical treatment

Zusammenfassung

Das femoroacetabuläre Impingement (FAI) ist ein pathologischer Mechanismus, der in jeder Person auftreten kann, wobei es häufiger in körperlich aktiven Personen, wie etwa Athleten, vorkommt. FAI wird von Knochendeformitäten am Femurkopf und/oder an der Pfanne, zusammen mit übermässigen und supraphysiologischen Hüftbewegungen verursacht. Die Folgen von FAI können Labrum- und Knorpelschäden, Hüftschmerzen und die Frühentwicklung von Hüftarthrose sein. Patienten mit symptomatischem FAI können funktionelle Einschränkungen während Alltags- und Sportaktivitäten, reduzierte Hüftmuskulatur und Veränderungen der Kinematik und Kinetik des Hüftgelenks in Vollbelastung präsentieren. Die Hüftchirurgie, entweder arthroscopisch oder mit offenem Verfahren durchgeführt, ist derzeit die Hauptstütze für das Management von symptomatischem FAI. Vorwiegend werden mit FAI verbundene, intraartikuläre Pathologien behandelt, wie Labrumrisse und Knorpelläsionen, und die grundlegenden Knochendeformitäten chirurgisch korrigiert. In vielen Case Series wurde gezeigt, dass Hüftchirurgie die Hüftschmerzen von FAI-Patienten reduzierte und sich ihre Hüftfunktion verbesserte. Es wurde zudem auch gezeigt, dass ein relativ grosser Anteil von Athleten mit FAI nach der Hüftchirurgie zum Sport zurückkehrte. Es wurde aber auch berichtet, dass FAI-Patienten nach der Hüftchirurgie eine unvollständige Erholung der Hüftmuskulatur und der Kinematik und Kinetik des Hüftgelenks während des Durchführens funktioneller Aktivitäten zeigten. Nicht-chirurgische Behandlungsmöglichkeiten mit dem Ziel die Hüftmuskulatur- und körperliche Funktion zu wiederherzustellen, wurden noch nicht als valide Alternativen zur Hüftchirurgie für das Management von symptomatischem FAI berücksichtigt. Zukünftige Forschungsprojekte sollten standardisierte Physiotherapieprotokolle für die Behandlung von symptomatischem FAI vorschlagen, und ihre Effektivität für die Reduktion der Hüftschmerzen und die Verbesserung der Hüftfunktion evaluieren. Weiterhin sollten randomisierte und kontrollierte klinische Versuche die chirurgische und nicht-chirurgische Behandlungsmöglichkeiten für das Management von symptomatischem FAI miteinander vergleichen, um die optimalen Bedingungen und den Zeitpunkt für die Hüftchirurgie zu definieren.

Schlüsselwörter: Hüfte; Schmerzen; Chirurgie; Rückkehr zum Sport; Körperliche Funktion; Nicht-chirurgische Behandlung

Introduction

Femoroacetabular impingement (FAI) is a pathomechanism caused by bony deformities at the proximal femur and/or acetabulum in conjunction with rigorous or supraphysiological hip ranges of motion. [1] FAI may lead to acetabular labrum lesions, hip pain, functional limitations during daily activities and sports, as well as to the development of early hip osteoarthritis. [1] A large number of recreational and professional athletes present with hip pain and functional limitations related to FAI. [2] While the etiologies of bony deformities at the acetabulum (pincer deformities) are not well understood, [3] there is growing evidence showing that deformities at the proximal femur (cam deformities) can be stimulated during skeletal growth by sport-specific loading patterns, which in turn can modify the distribution of the mechanical stimulus into the hip joint. [4,5] Indeed, FAI is frequently diagnosed in athletes participating in sports that require repeated changes of direction and cutting causing hip rotational loads across the hip joint (e.g., soccer). [6] However, FAI is also often diagnosed in athletes participating in sports that require high hip flexion, adduction and internal rotation motions (e.g., ice hockey) and supraphysiological hip ranges of motion (e.g., dance) (*Fig. 1*). [6] Athletes with symptomatic FAI are frequently forced to reduce or even discontinue their sport activities because of hip pain and resultant functional disability. [7] The aim of this narrative review is to report the results of studies that objectively investigated the physical function of patients with symptomatic FAI and its recovery after hip surgery. In addition, the rationale for explaining the potential efficacy of non-surgical treatments aimed at improving the muscle and physical function of symptomatic FAI patients is presented, as well as some perspectives for future research.

Physical function impairments in patients with symptomatic FAI

When the FAI pathomechanism was first described more than 10 years ago, [1] there was no focus on whether hip pain and functional limitations demonstrated by FAI patients during

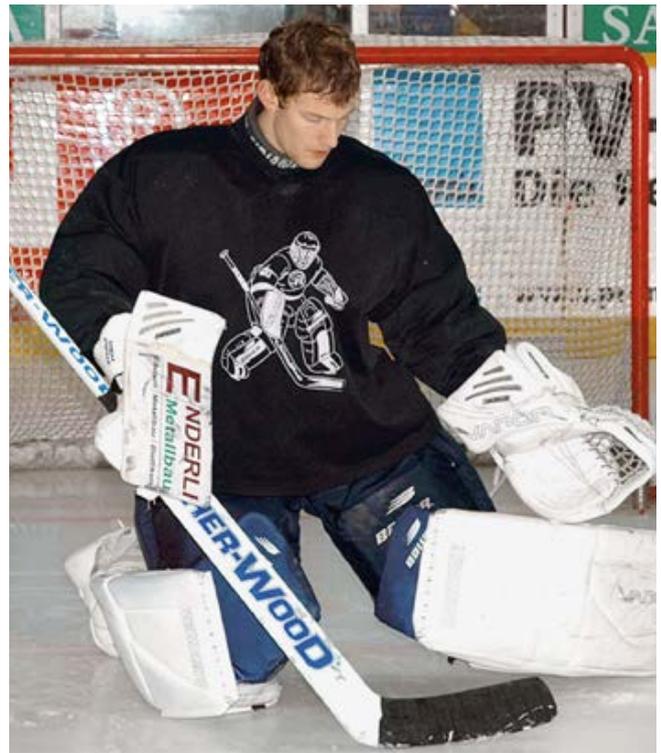


Figure 1: Butterfly position of ice hockey goaltenders with the hip in flexion and internal rotation.

daily and sport activities were also accompanied by significant hip muscle function impairments. Accordingly, few studies objectively investigated hip muscle function of FAI patients and, to our knowledge, not specifically in athletes. One study evaluated hip muscle strength in a group of symptomatic FAI patients (*Fig. 2*). [8] They demonstrated reduced hip muscle strength (i.e., muscle weakness) compared with matched healthy controls, especially for hip flexors and adductors. In addition, these patients also showed an impaired ability to activate the tensor fasciae latae muscle during maximal hip flexion. [8] Another study attempted to verify the



Figure 2: Test settings for the evaluation of hip flexor strength using an isokinetic dynamometer.

hypothesis that symptomatic FAI patients would present more hip muscle fatigue than matched healthy controls. [9] Despite the fact that FAI patients mainly experience hip pain and functional limitations while performing dynamic tasks for prolonged periods of time, [10,11] they did not show greater hip flexor muscle fatigue compared to controls. [9] Taken together, these results indicate that patients with symptomatic FAI might demonstrate a reduced ability to maximally activate their hip muscles, probably due to arthroscopic muscle inhibition, [8] but not a reduced ability to maintain a certain level of force over time.

The general hip muscle weakness observed in symptomatic FAI patients may potentially be related to kinematic and kinetic alterations observed in their symptomatic hip during level walking. [12] Specifically, FAI patients showed lower peak hip adduction, internal rotation and extension angles, as well as lower peak hip external rotation and flexion moments during the stance phase of gait compared with matched healthy controls. [12] If these hip joint kinematic and kinetic alterations observed during low-intensity activities like level walking are probably of little clinical significance, [13] it is expected that patients with symptomatic FAI would show greater functional deficits while performing highly demanding tasks like running and jumping. [8,14] Nevertheless, it is still not clear if these neuromuscular and physical impairments are always the consequence of altered hip mechanics and pain due to FAI, or if the presence of these impairments may also play a role in the development of symptomatic FAI. [8]

Surgical management of symptomatic FAI

The management of symptomatic FAI usually consists in a first trial of non-surgical treatments, which mainly include physical activity modification such as the reduction of excessive motion and demands on the hip, anti-inflammatory medication, and unspecified physical therapy. [15] In case these interventions are not successful, hip surgery is the main option for the management of symptomatic FAI. [16] During hip surgery, labral tears are repaired, debrided or reconstructed with the objective to maintain as much healthy labral tissue as possible. [17] An intact labrum creates indeed the labral seal that in turn plays an important role for joint lubrication and cartilage nutrition, as well as for load distribution within the hip joint. [17] If FAI already caused articular cartilage damages, chondroplasty or microfracture techniques are also implemented. [16] The underlying bony deformities at the proximal femur and/or acetabulum that cause FAI are surgically corrected. The original procedure to access the hip joint is open hip surgery with osteotomy of the greater trochanter and dislocation of the femur. [18] In the 10 last years, the improvement of surgical techniques and instrumentations resulted in an increased use of hip arthroscopy as a valid alternative to open hip surgery for the treatment of symptomatic FAI. [19] Hip arthroscopy is a very attractive procedure for athletes since it offers a less invasive approach, less muscle dissection, faster rehabilitation and potentially an earlier return to sport compared with open hip surgery. [20] However, it is technically demanding and mainly used for the treatment of traditional bony deformities. [21] On the other side, open hip surgery is increasingly adopted for the correction of more complex abnormalities, also with athletes. [21,22]

Physical function recovery after hip surgery for FAI

Hip surgery using both arthroscopic and open approaches demonstrated to be effective in relieving, or at least reducing, hip pain and in improving hip function of symptomatic FAI patients, including athletes. [16] However, it has to be considered that only case series (i.e., low level of evidence) showed improvements in pain and function after hip surgery for FAI. [23,24] A recent systematic review reported that on average 87% of athletes return to sport after hip surgery for FAI, and 82% return to the same level of sport as before the occurrence of the hip symptoms. [2] Professional athletes reported higher rates of return to sport than recreational athletes. Indeed, the formers usually experience socioeconomic pressures from trainers, teams, managers and sponsors for an early return to competition. [25,26] In contrast, recreational athletes frequently reduce or change their sport activity habits after hip surgery, or they even decide to discontinue sports. [2] Few and inconsistent results have been reported about the duration of return to sport after hip surgery for FAI. [2] Only one study investigated hip muscle strength recovery in a series of FAI patients who underwent hip arthroscopy, [27] but not specifically in athletes. Patients showed increases in muscle strength for all hip muscle groups ranging between 9% and 59% at 2 years follow-up compared to preoperatively. Persistent muscle strength deficit was however observed for the hip flexors (18%) at follow-up compared with matched healthy controls. [27] This may be due to the inability of patients in activating and therefore strengthening these muscles. [28,29] In addition, therapists are often very cautious in proposing strengthening exercises for these muscles because of the frequent occurrence of hip flexor tendinitis after hip arthroscopy. [28,29] On the other side, discordant results have been reported regarding the recovery to normal levels of hip joint kinematic and kinetic parameters during weight-bearing activities after hip surgery for FAI. [30,31] One study reported no functional changes while level walking at 8 to 32 months after open hip surgery for FAI compared to preoperatively. [30] In addition, these patients still demonstrated reduced hip frontal and sagittal plane ranges of motion, as well as reduced hip abduction and internal rotation moments during the stance phase of gait compared with matched healthy controls at follow-up. [30] In contrast, another study reported that hip sagittal and internal rotation ranges of motion returned to normal levels one year after hip arthroscopy during level walking, but not while stairs climbing. [31] These findings indicate that even if hip surgery can generally reduce hip pain and improve the perceived hip function, neuromuscular and physical impairments may still be present after surgery for FAI.

Non-surgical management of symptomatic FAI

The non-surgical management of symptomatic FAI, understood as the rehabilitation of an impaired muscle and physical function, has never really been considered as an effective alternative to hip surgery so far. Accordingly, there are nowadays no evidence-based recommendations indicating the physical characteristics (e.g., hip-specific muscle strength, lower limb muscle strength, postural balance) that should be addressed by rehabilitation regimens. On one side, it is well known that passive hip motion beyond impingement-free limits can exacerbate the hip symptoms and be harmful for the hip joint. [15] On the other side, the FAI mechanism not only includes a structural

pathological aspect (i.e., bony deformities), but also a component related to hip motion. It might be supposed that changes in hip motion and control during functional activities may be achieved through an improved neuromuscular function of the hip, pelvis, trunk and lower limbs. These changes may in turn have an effect on the occurrence of FAI in patients with mild to moderate bony deformities. The influence on hip pain of non-surgical interventions aimed at improving the neuromuscular function around the hip has been poorly examined in symptomatic patients with FAI-related bony deformities and/or intra-articular hip pathologies so far. [32,33] One study investigated the effect of a non-surgical intervention in a series of 4 patients with evidence of acetabular labral tears. [32] The aim of this physical therapy treatment was to improve hip and lumbopelvic joint stability, abdominal and hip muscle strength, dynamic biomechanical control of the lower extremities, and to progress to sport-specific functional activities. Patients underwent 3 physical therapy sessions a week for an average of 12 weeks. At 6-month follow-up, patients reported decreased hip pain as well as improved function. Another study investigated the effect of non-surgical treatment in 58 patients with hip pain secondary to FAI or hip dysplasia. [33] This intervention included patient education, activity modification, medications, and physical therapy aimed to decrease the anterior femoral glide with appropriate muscle retraining and to optimize muscle strength around the pelvis. Patients underwent physical therapy sessions over 3 months. At follow-up, 44% of them improved hip function and decreased hip pain, while 56% decided to undergo hip surgery. Despite the low level of evidence of these studies, there is a growing trend to implement similar non-surgical interventions in patients with symptomatic FAI. [34] This can be explained by the fact that not all symptomatic FAI patients showed to benefit from hip surgery. [35] A relatively high rate of FAI patients, ranging between 0 and 30%, has been reported to be unsatisfied with their postoperative outcomes. [36] In addition, since the current evidence that sup-

port the effectiveness of hip surgery in reducing hip symptoms and improving function is limited to case series (level of evidence IV), [23,24] no randomized controlled trial has demonstrated the superiority of hip surgery compared with non-surgical or sham treatments so far.

Perspectives

Besides studies aimed at optimizing FAI diagnosis, surgical procedures and resultant postoperative outcomes, future research should also focus on rehabilitation regimens for the non-surgical management of symptomatic FAI patients. Physical therapy protocols should include hip-specific and lower limb strengthening, neuromuscular control, and postural balance exercises aimed at improving the neuromuscular function of the hip, pelvis, trunk and lower limbs in an attempt to induce an effect on hip motion and control during functional activities (*Fig. 3*). Standardized non-surgical treatment protocols have to be proposed and their effectiveness in reducing hip symptoms be evaluated.

Since the importance of hip muscle function for normal lower limb kinematics and kinetics has only been recently acknowledged, [8,37] there is nowadays scientific interest in appraising the physical therapy exercises that can optimally activate the hip muscles and therefore induce the desired neuromuscular improvements. In addition, randomized controlled trials should compare the outcomes following standardized non-surgical protocols and hip surgery, [23] with the objective to understand under which conditions (e.g., type and amount of bony deformity, presence and position of labral lesions, degenerative status of the hip joint, physical activity level) symptomatic FAI patients could benefit from a non-surgical treatment, and when they should better be surgically managed. Since non-surgical interventions can however neither treat the FAI-related intra-articular hip pathologies nor



Figure 3: Physical exercises used for training the neuromuscular function of the hip, pelvis, trunk and lower limbs.

the underlying bony deformities, the hip joint degenerative process caused by the FAI pathomechanism may progress, even in the absence of hip symptoms. Thus, imaging surveillance of the hip joint should be regularly performed. Moreover, recent studies showed that a relatively high proportion of asymptomatic subjects present with bony deformities and acetabular labrum alterations comparable with those demonstrated by symptomatic FAI patients. [38–40] Thus, future research should also investigate if non-surgical physical therapy interventions could also be implemented with these asymptomatic subjects to prevent the occurrence of hip symptoms.

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