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HIP

# Femoroacetabular impingement in 45 professional athletes: associated pathologies and return to sport following arthroscopic decompression

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**Abstract** Femoroacetabular impingement (FAI) occurs when an osseous abnormality of the proximal femur (cam) or acetabulum (pincer) triggers damage to the acetabular labrum and articular cartilage in the hip. Although the precise etiology of FAI is not well understood, both types of FAI are common in athletes presenting with hip pain, loss of range-of-motion, and disability in athletics. An open surgical approach to decompressing FAI has shown good clinical outcomes; however, this highly invasive approach inherently may delay or preclude a high level athlete's return to play. The purpose of this study was to define associated pathologies and determine if an arthroscopic approach to treating FAI can allow professional athletes to return to high-level sport. Hip arthroscopy for the treatment of FAI allows professional athletes to return to professional sport. Between October 2000 and September 2005, 45 professional athletes underwent hip arthroscopy for the decompression of FAI. Operative and return-to-play data were obtained from patient records. Average time to follow-up was 1.6 years (range: 6 months to 5.5 years). Forty two (93%) athletes returned to professional competition following arthroscopic decompression of FAI. Three athletes did not return to play; however, all had diffuse osteoarthritis at the time of arthroscopy. Thirty-five athletes (78%) remain active in professional sport at an average follow-up of 1.6 years. Arthroscopic treatment of FAI allows professional athletes to return to professional sport.

**Keywords** Femoroacetabular impingement · Cam · Pincer · Osteoplasty · Hip arthroscopy

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## Introduction

In publications dating back several decades, irregularities in the morphology of the femoroacetabular articulation have been implicated as a possible source of hip pain in young, active athletes. A French article published in 1979 described hip pain associated with structural abnormalities of the proximal femoral neck in athletes participating in hockey, football, soccer, rugby, martial arts, and tennis [5]. More recently, developments pioneered by open hip surgeons have shown that morphologic abnormalities of both the femur and acetabulum underlie a large number of labral and chondral injuries in the hip [1, 29]. Wenger et al. [29] noted the presence of osseous abnormalities, including dysplasia and femoroacetabular impingement (FAI), in the majority of patients with labral tears. This suggests that isolated treatment of soft tissue pathologies may not be adequate without concomitantly addressing underlying structural abnormalities.

The concept of FAI has been defined by Ganz and colleagues [1, 8, 27]. In this condition, a structural or spatial abnormality of the femur (cam) or acetabulum (pincer) damages the chondrolabral structures during normal joint movement. The most common situation is a mixed cam and pincer pathology, occurring along the anterior femoral neck and the anterior–superior acetabular rim. In high flexion and internal rotation movements,

abutment and impingement of the labrum and cartilage occurs. The precise etiology of FAI is not well understood. Sub-clinical slipped capital femoral epiphyses [15, 25], mal-union of femoral neck fractures [6], and decreased femoral anteversion [26] are described causes of cam impingement. Relative posterior opening of the acetabulum (acetabular retroversion) or global (coxa profunda) over-coverage of the femur by the acetabulum are described causes of pincer impingement [23, 24]. Cam and pincer lesions lead to distinct patterns of labral and chondral damage [1, 10] and long-standing impingement is likely a significant cause of previously described idiopathic hip joint degeneration [1].

Ganz et al. developed an open surgical dislocation approach to decompress FAI [7, 13]. This technique has demonstrated good results of FAI decompression in a general population [2]. However, we believe that an arthroscopic approach involves less post-operative morbidity and allows patients, including professional athletes, to return to high-functioning lifestyles [28]. The purpose of this study was to define associated pathologies and determine if professional athletes could return to high-level athletics following arthroscopic decompression of FAI.

## Methods

### Patient selection

A retrospective chart review was performed of all professional athletes presenting for arthroscopic treatment of FAI by the senior author between October 2000 and September 2005. All athletes presented with debilitating hip pain and an inability to participate in their sport. All were diagnosed with FAI based on physical and radiographic examination. Physical examination criteria included a positive impingement test [14] or flexion–abduction–external rotation (FABER) test. A positive impingement test was defined as groin pain with 90 degrees of hip flexion and maximal internal rotation. A positive FABER test was defined as asymmetry in the distance between the lateral knee and the exam table between the injured hip and the non-injured hip. Radiographic criteria included decreased anterior and superior femoral head–neck offset, acetabular retroversion (as defined by a positive cross-over sign), or coxa profunda (as defined by the medial acetabular border overlapping the ilioischial line).

For these athletes with documented physical and radiographic evidence of FAI, conservative treatment was limited to only 6 weeks. Based on evidence described by Beck and colleagues [1], our thought was that conservative treatment could not address the underlying bony abnormalities and any further treatment delay in these highly active patients would likely precipitate further irreversible damage to the articular cartilage. Inclusion criteria for this study included professional athletes with at least one positive physical exam finding, at least one positive radiographic finding, and failure of at least 6 weeks of conservative therapy. Forty-five professional athletes from various sports met the inclusion criteria and were included in the study (Table 1). There were 42 male and 3 female patients.

### Arthroscopic procedure

The modified supine approach to hip arthroscopy was used [3]. Two portals (anterior, anterolateral) were established and a third portal (distal lateral accessory) was established as needed [12]. At the time of arthroscopy, the central compartment of the hip was first inspected.

Pincer lesions were typically identified in the superior acetabular quadrant. For the treatment of small pincer lesions (<2 to 3 mm), osteoplasty of the proximal femoral neck was occasionally sufficient to relieve the impingement [28]. Patients with moderate or large-sized lesions underwent acetabular rim trimming, using an arthroscopic osteotome or 5.5 mm round motorized burr [22].

Acetabular labral tears were arthroscopically identified, and based on previous research on the vascularity of the labrum [9, 11], detached and peripheral midsubstance tears were typically repaired [12, 22]. Care was taken to preserve as much healthy, viable labrum as possible, however, degenerative or frayed tissue was debrided to a stable remnant.

Labral repair was performed with suture anchors to repair detached labral tears or to re-fix the labrum following iatrogenic detachment for complete resection of pincer lesions. The previously described technique involved placement of the anchors high on the acetabular rim in the area of detachment [12]. Typically, one bioabsorbable anchor (BioRaptor, Smith+Nephew, Andover, MA, USA)

**Table 1** Pre-operative sports activities of the 45 professional athletes

| Sport | No. of patients |
|---|---|
| Hockey | 24 |
| Golf | 6 |
| Football | 5 |
| Soccer | 3 |
| Dance | 2 |
| Baseball | 2 |
| Martial arts | 1 |
| Tennis | 1 |
| Jockey | 1 |
| Total | 45 |

was placed at the 12:00 acetabular position, and re-inforcement was placed either anteriorly or posteriorly of this area as needed. One limb of suture (Ultrabraid, Smith+Nephew, Andover, MA, USA) was passed between the labral tissue and the rim, and was retrieved through the substance of the labral tissue. In cases of inadequate availability of labral substance or in patients with highly degenerative, friable tissue, the suture was passed around the labral tissue. Standard arthroscopic knots fixed the repair to the rim. For midsubstance labral tears, a suture passer looped an 0-Vicryl around the torn tissue to approximate the edges of the midsubstance split.

The condition of the articular cartilage was evaluated according to the Outerbridge Classification System [18]. For this study, the Outerbridge Classification System was defined as follows: grade 0, normal cartilage; grade 1, cartilage with softening and swelling; grade 2, a partial thickness defect with fissures on the surface that do not reach the subchondral bone or exceed 1.5 cm in diameter; grade 3, fissuring to the level of the subchondral bone in an area with a diameter more than 1.5 cm; and, grade IV, exposed subchondral bone [18]. Chondral procedures performed in this group included chondroplasty and microfracture of lesions of the femoral head and acetabulum as needed.

Following inspection of the central compartment, traction was released and the peripheral compartment was evaluated for cam lesions. A dynamic examination of the hip in all motion planes allowed for direct visualization of impingement at the femoroacetabular interface. For the treatment of cam lesions, an osteoplasty was performed with a 5.5 mm round motorized burr, restoring the anatomic concavity of the femoral head–neck junction [28]. Burring was performed from superior to inferior along the anterior femoral head–neck junction, to a depth of approximately 5–7 mm and a width of approximately 8–12 mm. Care was taken to avoid resecting too distally along the femoral neck to avoid the lateral epiphyseal vessels. A final dynamic examination was performed to confirm adequate decompression, and a lack of entrapment of the labrum during joint motion.

In general, the above-described procedure took approximately 2–3 h, depending on the degree of labral and chondral pathology. Traction time was limited to less than 2 h to reduce the risk of neurovascular compromise.

### Post-operative management

Post-operative medical prophylaxis included an aspirin or a low-molecular weight heparin, a non-steroidal anti-inflammatory, and an antibiotic. Each of the 45 athletes underwent post-operative rehabilitation according to the following generalized protocol that was devised based on personal experience. For basic procedures involving decompression of FAI and labral treatment, weightbearing was restricted to 20 pounds, flatfoot for 4 weeks. A brace was prescribed to be worn for 10 days to protect the hip and limit abduction and rotation. Continuous passive motion (CPM) was used to apply 0–90 degrees of hip flexion for up to 8 h per day for 4 weeks. Night boots were worn for ten post-operative days to limit rotation during sleep. If capsular modification procedures (thermal capsulorrhaphy or capsular plication) were performed, rotation precautions were extended for a total of 21 days to avoid capsular stress. If microfracture was performed, weightbearing restrictions and CPM use were extended for a total of 8 weeks.

Physical therapy exercises were implemented within four post-operative hours. It is our belief, based on clinical observation, that this, in addition to an early emphasis on passive hip motion (particularly internal rotation) reduces the incidence of adhesion formation. Active hip flexion was limited for 4 weeks, based on clinical observation, to minimize the risk of hip flexor tendonitis.

Athletes were typically allowed to return to full competitive activity between 12 and 16 post-operative weeks. Return-to-play statistics were determined by retrospective chart review and personal follow-up communication with the athletes.

## Results

The average age of the athletes at the time of surgery was 31 years (range: 17–61). Eleven athletes (24%) previously underwent hip arthroscopy by multiple primary surgeons for the treatment of labral and chondral pathologies and experienced a recurrence of hip symptoms. The average time to follow-up was 1.6 years (range: 6 months to 5.5 years).

Twenty-two athletes (49%) were treated for an isolated cam lesion and three athletes (7%) were treated for an isolated pincer lesion. Twenty-one athletes (47%) had a mixed pathology of both cam and pincer lesions.

All of the athletes had acetabular labral tears. Twenty-five patients (56%) underwent either labral repair or re-fixation following rim trimming with suture anchors (average 1.3 anchors per patient, range: 1–3). Twelve patients (27%) had intra-substance labral repair. Five patients had labral debridement; one patient had a detached tear, one had frayed labral tissue, and three patients had complex tears consisting of detached, frayed, and flap components. Two patients were labral deficient from a previous arthroscopic debridement. They underwent labral grafting using an iliotibial band autograft.

Twenty-one patients (47%) had a grade IV acetabular chondral defect; 14 underwent arthroscopic microfracture,

5 underwent thermal chondroplasty, and 2 patients had no treatment due to the diffuseness of their disease. Three patients (7%) had a grade IV femoral head chondral defect; one was treated with microfracture, one with chondroplasty, and one patient had no treatment due to the diffuseness of his disease. Seventeen (38%) had a grade I–III acetabular chondral defect (13 treated with chondroplasty and 1 treated with microfracture) and 11 (24%) had a grade I–III femoral head chondral defect (all 11 were treated with chondroplasty). Four patients (one baseball player, one football player, one hockey player and 1 golfer) had extensive diffuse OA at the time of arthroscopy, but opted to delay arthroplasty.

Twenty-six patients (58%) had a partial tear of the ligamentum teres and 3 patients (7%) had a complete ligamentum teres avulsion. Thirteen (29%) patients underwent thermal capsulorrhaphy and 9 (20%) underwent plication for capsular redundancy. Seventeen patients (38%) had loose bodies in the joint and two patients required excision of myositis ossificans of the rectus femoris. Three patients (7%) underwent cheilectomy of a stenotic cotyloid fossa and 9 patients (20%) underwent arthroscopic release of a tight iliopsoas.

Figure 1 illustrates restoration of femoral head–neck concavity in an athlete treated for cam impingement (Fig. 1) and Fig. 2 illustrates successful removal of the anterior acetabular overhang in an athlete treated for pincer impingement (Fig. 2).

Forty-two athletes (93%) returned to professional sport following hip arthroscopy. Three players (1 football player, 1 hockey player, and 1 baseball player) did not return to play following arthroscopy. Each of these patients had diffuse osteoarthritis at the time of arthroscopy.

Five athletes (11%) required re-operation. Three underwent lysis of adhesions and two had symptomatic treatment of extensive osteoarthritis. All of the patients who underwent revision surgery for lysis of adhesions returned to professional play and the two with extensive osteoarthritis did not return to play.

Thirty-five of the 45 athletes (78%) remained active at the professional level at an average of 1.6 years after hip arthroscopy.

## Discussion

Intra-articular hip injuries are a recognized cause of pain, mechanical symptoms, and disability in athletes. Traumatic intra-articular injury results from acute injury, including hyperabduction injuries, direct hip contact, and joint dislocation or subluxation. Atraumatic hip injury, however, is less well understood. Various motions exerted during sport, particularly flexion combined with internal rotation (hockey-goalie stance), have been suggested as potential causes of overuse hip injury [19, 21]. In this position, a cam lesion extending anteriorly or superiorly from the proximal

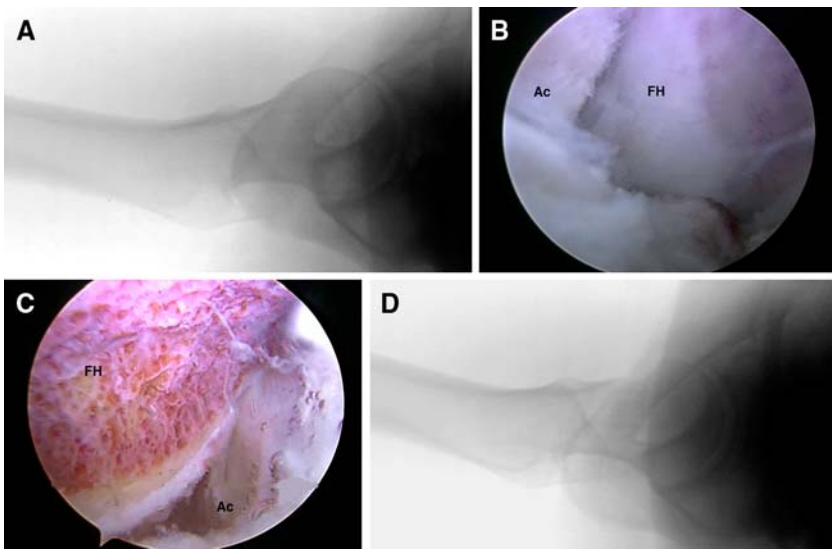


**Fig. 1** A 27-year-old professional hockey player was evaluated for right hip pain. **a** A pre-operative cross-table lateral radiograph demonstrated convexity at the anterior femoral head–neck junction. **b** The presence of a cam lesion was verified arthroscopically. The femoral head (*FH*) and acetabulum (*Ac*) are visualized in the peripheral hip compartment with the camera in the anterior portal. **c** A motorized burr was used to restore anterior concavity at the head–neck junction. This was visualized at the superior acetabular (*Ac*) position (12:00) with the camera in the anterior portal. **d** A post-operative film verified successful decompression of the cam impingement and restoration of the femoral head–neck junction concavity

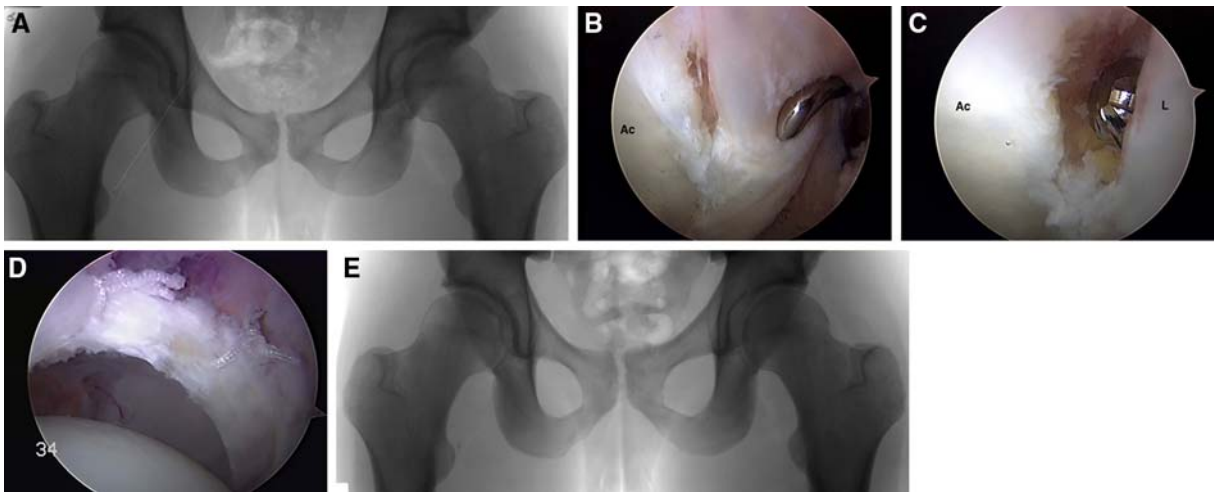


**Fig. 2** A 22-year-old professional football player was evaluated for right hip pain. **a** A pre-operative AP radiograph demonstrated a cross-over sign of the right acetabulum, indicating acetabular retroversion. **b** The presence of a pincer lesion was verified arthroscopically with the camera in the anterolateral portal with excessive bone along the anterior–superior acetabulum (*Ac*). **c** A motorized burr in the anterior portal resected the lesion with the burr shield placed against the labrum (*L*) for protection. **d** The labrum was fixed back to the rim using two suture anchors. **e** A post-operative film verified the successful removal of pincer impingement and lack of retroversion in the superior region of the acetabulum

femoral neck would impinge at the anterosuperior acetabular rim. Combining this understanding with recent reports by Wenger et al. [29] and Ganz et al. [1, 2, 8, 13], morphological abnormalities of the femoroacetabular joint have been closely examined as possible underlying sources of atraumatic hip injuries in athletes. Ganz and colleagues described FAI resulting from structural abnormalities of the proximal femoral neck (cam), acetabular rim (pincer), or most commonly, a combination of the two pathologies (mixed). Damage to the articular cartilage and acetabular labrum results from this pathologic bony contact and FAI is a likely trigger of early hip joint degeneration. In our experience, FAI is a common problem that has only recently been recognized in athletes with a primary hip complaint.

An open surgical dislocation approach was first described to treat hip impingement [7]. This technique showed good midterm results in a general population [2]. However, increasing recognition of FAI in a high-demand, competitive athletic population encouraged the development of a less invasive arthroscopic approach to facilitate prompt return to competitive play.

Various studies have demonstrated that hip arthroscopy is a safe and effective intervention in athletes with intra-articular injuries [4, 17, 19, 20]. Philippon reported on a series of ten elite athletes who underwent hip arthroscopy for labral debridement with thermal capsulorrhaphy [20]. All of the athletes returned to high-level athletic activities. McCarthy et al. [17] reported 80% excellent results following hip arthroscopy in elite athletes (average follow-up of 23.6 months). Byrd et al. [4] reported a series of 44 hip arthroscopies in 42 recreational, high school, collegiate, elite, and professional athletes. Post-operative improvement, as quantified by the modified Harris Hip Score, was present in all classes of athletes and in athletes undergoing any arthroscopic procedure (removal of loose bodies, debridement of ligamentum teres, excision of osteophyte, labral excision, microfracture, chondroplasty). Byrd et al. reported better results in athletes who recalled a traumatic onset to their hip symptoms, when compared to those with an acute or insidious onset. The authors suggested that an unaddressed pre-disposition to injury might have had a negative impact on self-reported outcomes in athletes [4].

FAI may be the unaddressed pre-disposition to which Byrd and colleagues were alluding. While these above articles demonstrated successful outcomes following debridement procedures in athletes, there are a few caveats that must be addressed. First, it is likely that simple excision of damaged or diseased tissue, like with meniscal tears or loose bodies, can provide short-term abatement of pain and mechanical symptoms, and allow an athlete to return to professional athletics. However, recent studies have shown that simple hip debridement procedures failed to address the primary pathology in a vast majority of cases [1, 29]. A recent unpublished study performed by the senior author showed that a major cause of revision hip arthroscopy in all patients was treatment of labral and chondral re-injury and decompression of previously unaddressed FAI. Future studies examining the clinical and radiographic long-term outcomes of athletes treated with debridement procedures need to be compared to those athletes treated for FAI at an early stage of this disease. The purpose of this study was to simply state that despite the fact that FAI surgery is a more

extensive procedure than debridement, professional athletes can still return to play following this procedure.

An arthroscopic approach to treat FAI was recently reported [28]; however, early outcome studies are lacking. The results of this study show that professional athletes with FAI can return to high-level competitive sport following this procedure. Ninety-three percent of athletes returned to their previous level of sport. Three athletes did not return to sport (1 hockey player, 1 football player, and 1 baseball player), however all had diffuse hip osteoarthritis present at the time of arthroscopy. One patient (a senior PGA golfer) was able to return to sport following arthroscopy, despite his diffuse osteoarthritis. Based on this information, it seems that arthroscopic treatment of FAI in the presence of OA can allow patients to return to low-impact, however, not likely high-impact professional sports. A larger cohort of patients is needed to test this hypothesis.

Avascular necrosis (AVN) and femoral neck fracture are recognized risks of osteoplasty. A recent study showed that up to 30% of the femoral neck may be resected before it is structurally compromised [16]. In this series of patients, no post-operative cases of AVN or femoral neck fracture were diagnosed. Additional potential complications include adhesion formation at either the capsulolabral margin or between the capsule and the site of bony resection. In this series of 45 athletes, 3 patients (7%) required revision arthroscopy for the lysis of adhesions (LOA). All athletes returned to competitive sport following revision arthroscopy for LOA. Two additional athletes had extensive OA at the time of primary arthroscopy and subsequently underwent revision arthroscopy for symptomatic treatment of OA, including osteophyte debridement. Both did not return to professional athletics due to the extent of their disease. There were no reported cases of heterotopic ossification or neurovascular compromise, including lateral femoral cutaneous, sciatic, and pudendal neuropraxia, reported, although this statistic may have been underestimated due to the nature of this professional athlete cohort.

A limitation of this study was the inherent selection bias involved with the study of professional athletes. This patient sub-group was financially motivated to return to play and may have been less likely to report post-operative symptoms and complications than the rest of patients treated for FAI. Despite this, we believed that a return-to-play analysis was critical to assess the outcomes of FAI treatment in a high-demand population. This cohort of professional athletes was debilitated prior to hip arthroscopy, and following intervention, was able to perform in physically intense professional sport activities. Also, the athletes' precise reason for retirement and whether it was related to their hip injuries was difficult to discern. For this reason, given the relatively short span of all professional athletes' careers, we chose to include all athletes at a minimum of 6 months post-operative. This time period was selected as an ample time period for completion of post-operative rehabilitation and return to sport. Another limitation of this study was the lack of follow-up subjective and objective data. Current outcomes instruments (modified Harris Hip score and the Non-Arthritic hip score) have not been validated for use in high-level athletes. It is our belief that these scoring systems fail to address the activities that are most limiting to athletes, and hence, underestimate the degree of debilitation in professional athletes. Evaluating the applicability of current scoring systems in athletes, and developing new outcomes instruments for athletes will be the focus of future studies. Other limitations of this study included unequal distribution of gender (42 males and 3 females) and professional sports. Because different sports place different demands on the hip, we cannot draw conclusions among the various sports.

The arthroscopic treatment of FAI represents the evolution of hip arthroscopy. In the past, soft tissue pathologies were treated in isolation, without addressing underlying impinging osseous abnormalities. Recent developments, particularly by Ganz and colleagues, have enlightened us to the pathology of FAI and the associated treatment options. In order to treat high-demand patients with FAI, an arthroscopic technique was developed. This study has demonstrated that full return to professional competitive sport is possible following arthroscopic treatment of FAI. Additional studies are needed to determine the effect on long-term joint degeneration of early surgical intervention to treat FAI.

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