High Incidence of Athletic Pubalgia Symptoms in Professional Athletes With Symptomatic Femoroacetabular Impingement

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Purpose: The purpose of this study was to identify the incidence of symptoms consistent with athletic pubalgia (AP) in athletes requiring surgical treatment for femoroacetabular impingement (FAI) and the frequency of surgical treatment of both AP and FAI in this group of patients. **Methods:** Thirty-eight consecutive professional athletes, with a mean age of 31 years, underwent arthroscopic surgery for symptomatic FAI that limited their ability to play competitively. In all cases a cam and/or focal rim osteoplasty with labral refixation or debridement was performed. In 1 case concomitant intramuscular lengthening of the psoas was performed. Retrospective data regarding prior AP surgery and return to play were collected. **Results:** Thirty-two percent of patients had previously undergone AP surgery, and 1 patient underwent AP surgery concomitantly with surgical treatment of FAI. No patient returned to his previous level of competition after isolated AP surgery. Thirty-nine percent had AP symptoms that resolved with FAI surgery alone. Of the 38 patients, 36 returned to their previous level of play; all 12 patients with combined AP and FAI surgery returned to professional competition. The mean duration before return to play was 5.9 months (range, 3 to 9 months) after arthroscopic surgery. **Conclusions:** There is a high incidence of symptoms of AP in professional athletes with FAI of the hip. This study draws attention to the overlap of these 2 diagnoses and highlights the importance of exercising caution in diagnosing AP in a patient with FAI. **Level of Evidence:** Level IV, therapeutic, retrospective case series.

Femoroacetabular impingement (FAI) describes 2 main variations of morphologic abnormalities of the hip and resultant observed patterns of chondral and labral injury: (1) cam impingement resulting from loss of offset of the femoral head-neck junction and (2) pincer impingement due to focal rim lesions or cephalad retroversion.[1] Current treatment for FAI involves osteoplasty of proximal femoral and acetabular dysmorphology with labral debridement or refixation. Both open and arthroscopic approaches have been reported with favorable clinical outcomes in 75% to 95% of patients, with up to 93% of athletes returning to sport.[2-9]

Athletic pubalgia (AP) refers to a syndrome of disabling lower abdominal and inguinal exertional pain with progression to include adductor pain in high-performance athletes.[10-12] Symptoms occur with resisted hip adduction or with resisted abdominal contractions. The mechanism is postulated to be a complex injury to the flexion/adduction apparatus of the lower abdomen and hip.[10] To enhance the comprehension of the spectrum of injuries observed in AP, the "pubic joint" has been described as the second joint within the pelvis, with the hip joint being the first.[13] This second joint comprises the entirety of the right and left pubic symphyses with all of their musculotendinous attachments. Asymmetric distribution of ex-

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treme forces around this joint, as is most commonly seen in the elite athlete, may result in the constellation of abdominal and pelvic injuries found in AP.[11,13] Surgical repair is aimed at the various structures that normally attach to the pubic symphysis and/or selective epimysiotomy or detachment.[13-15] An overall success rate of greater than 95% in returning patients to their previous level of activity has been reported.[13]

Both FAI and AP are frequently reported in high-performance athletes, most commonly in soccer, hockey, football, and baseball players.[7,13,16] When viewed as a group, such injuries account for a significant proportion of lost playing time and early retirement in professional athletes. Although it has been suggested that these should be viewed in concert when examining an athlete presenting with groin pain, an association between the 2 has not previously been shown. Both conditions often present with a similar constellation of clinical symptoms, including groin discomfort and restricted range of motion (ROM).

The hip is a ball-and-socket type of joint with 3 degrees of freedom. Loss of clearance between the femoral neck and acetabular rim may compromise maximum hip excursion in multiple planes.[17-19] This abnormal bony contact and resultant restriction in terminal motion in the high-performance athlete due to FAI may result in compensatory stresses on the lumbar spine, pubic symphysis, sacroiliac joint, and posterior acetabulum. These alterations in hip joint mechanics due to underlying impingement may result in excessive strains and secondary injury to the posterior inguinal wall, resulting in symptomatic AP. The purpose of this study was to identify the incidence of symptoms consistent with AP in athletes requiring surgical treatment for FAI. Our hypothesis was that some athletes may manifest AP symptoms due to compensatory stresses from FAI; moreover, surgical correction of FAI may resolve these symptoms.

METHODS

This study was approved by our institutional review board. From April 2005 to April 2010, 38 consecutive professional athletes underwent arthroscopic surgery for the treatment of symptomatic FAI that limited their ability to return to competitive play. The group included 9 baseball players, 13 football players, 8 hockey players, 5 soccer players, 2 basketball players, and 1 skater (Table 1). All patients were men, with a mean age of 31 years (range, 19 to 35 years).

Throughout our article, we describe patients as having FAI symptoms, defined as hip or groin pain, and/or AP symptoms, defined as lower abdominal or adductor pain. Three subsets of patients are described. The first consists of 12 patients who presented with both FAI and AP symptoms and required surgical treatment of both the FAI and AP. Of these, all but 1 initially presented to a general surgeon specializing in the treatment of AP. The last patient initially presented to the senior author's sports medicine/hip preservation practice. Because of a lack of complete objective data in the records, we cannot report the exact time line between AP and FAI surgery for all the patients. The second subset comprises 15 patients who presented with both FAI and AP symptoms, in whom both sets of symptoms resolved after surgical treatment of FAI alone. The final subset, consisting of 11 patients, presented with FAI symptoms alone and underwent surgical treatment. The algorithmic approach taken by the senior authors (W.C.M. and B.T.K.) will be described.

Table 1. *Preoperative Sporting Activities of 38 Professional Athletes*

Sport	No. of Patients	No. of Patients Undergoing AP Surgery
Football	13	4
Baseball	9	2
Hockey	8	4
Soccer	5	2
Basketball	2	0
Skating	1	0
Total	38	12

For the first subset of patients who presented to a general surgeon with both FAI and AP symptoms, histories and physical examinations were conducted with careful attention to 3 sets of diagnoses: AP, hip, and other causes. Patients with AP pain describe abdominal/adductor pain that is primarily exertional in nature (resisted sit-ups) and often predictable with initiation of forceful activities such as sprinting and changes of direction.[11] The pain may also affect normal activities such as coughing, sneezing, or rolling over in bed at night.[11] The pain may vary from side to side, depending on patterns of compensation, and involve multiple sites of soft-tissue attachments, including the rectus abdominis and specific adductor muscles. Specific resistance tests for each of the muscles attaching to or crossing the pubic symphysis or joint were used in assessing the patient with AP symptoms. Localized tenderness over the pubic symphysis, distal rectus abdominis/conjoined tendon, or proximal adductor tendon is also helpful in localization of the

pathology.[20] Specialized pelvic magnetic resonance imaging (MRI) and magnetic resonance arthrography studies of the hip were performed on all patients to assess for AP and overlapping ball-in-socket hip injuries. At the time of magnetic resonance arthrography, the use of dedicated Sensorcaine (AstraZeneca LP, Wilmington, DE) or lidocaine protocols allowed for both diagnostic and therapeutic benefits. Those patients with diagnosed AP but who had relief of concomitant FAI symptoms after intra-articular injection and had findings of a labral tear on clinical examination and MRI were diagnosed with FAI, and surgical treatment of FAI was planned to follow the AP surgery. Surgical treatment of AP varied depending on the precise pathology with both direct repairs of defects and repairs or releases of compensatory injuries.

The diagnosis of symptomatic FAI was made based on clinical examination and imaging studies performed by a sports medicine orthopaedist, specializing in hip preservation (B.T.K.). A complete examination of the hip and surrounding structures was performed by use of the positionally based method described by Martin et al.[21] Intra-articular hip lesions were identified with pain during flexion, adduction, and internal rotation (FADIR test).[22] All athletes in the study were examined with an anteroposterior pelvis radiograph, an anteroposterior radiograph of the affected hip, an elongated-neck lateral view (Dunn lateral radiograph), and a false-profile radiograph (Fig 1).[23] The Dunn lateral view has been validated to characterize the cam deformity of FAI, with a sensitivity of 91%, specificity of 88%, positive predictive value of 93%, negative predictive value of 84%, and accuracy of 90%.[24] Radiographic assessment included the femoral neck-shaft angle, the Tönnis angle, the center-edge angle of Wiberg (normally >25°), the femoral head-neck offset, and acetabular version (the so-called crossover sign represents a retroverted acetabulum).[25] MRI of the hip was performed by use of coronal inversion recovery and axial fast spin-echo body coil images, as well as high-resolution surface coil images of the hip in the sagittal, axial, and oblique coronal planes by fast spin-echo techniques, for evaluation of intrinsic lesions, including the articular cartilage (Fig 2).[26] Athletes with a documented labral tear and pain with the FADIR test were administered an injection of lidocaine with corticosteroid under ultrasound guidance.[27] Those who had temporary relief of their FAI symptoms were treated with hip arthroscopy. Computed tomography was used to assess femoral version and the extent of osseous abnormalities and to evaluate the amount of resection to be addressed during hip arthroscopy.[23]

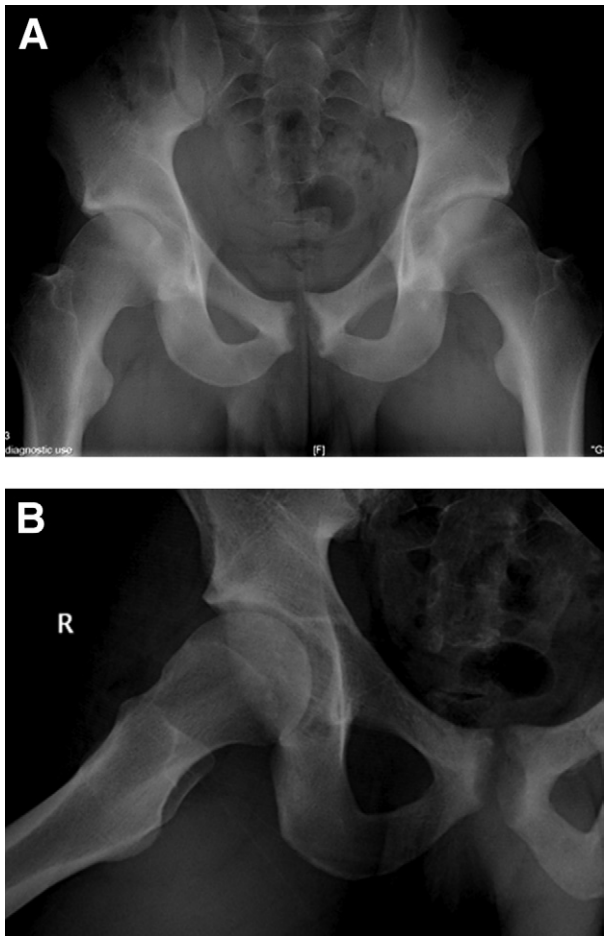

Figure 1. (A) Anteroposterior and (B) Dunn lateral radiographs of right hip showing loss of femoral offset and focal cephalad retroversion of acetabulum consistent with FAI in a football player with groin pain.

All patients who underwent hip arthroscopy had an alpha angle greater than 50° and a documented anterosuperior labral tear. In all cases an arthroscopic cam and/or focal rim osteoplasty with labral refixation or debridement was performed (Fig 3). In 1 case, concomitant intramuscular lengthening of the psoas was performed for symptomatic psoas impingement. Postoperatively, patients' extremities were placed in a continuous passive motion device daily for 4 weeks, with flexion of the hip from 30° to 70°. Weight bearing was restricted to 20-lb foot-flat weight bearing on the affected leg for 4 weeks. Gradual physical therapy and strengthening were started at 4 weeks. Retrospective data regarding subjective clinical outcome, previ-

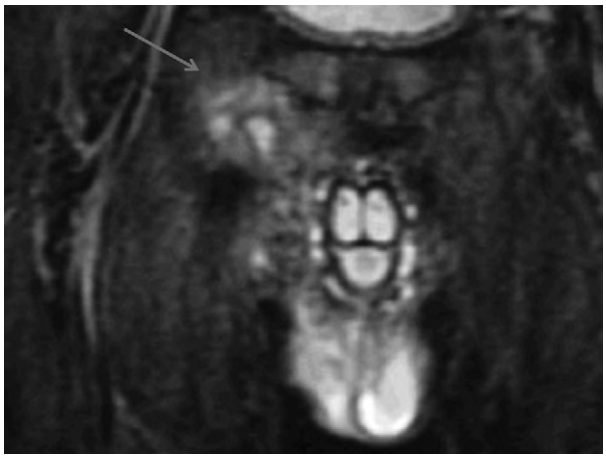

FIGURE 2. T2-weighted coronal magnetic resonance image showing edema and injury to adductor musculature origin (arrow), as well as abdominal wall musculature and fascia.

ous AP surgery, ability to return to play, and duration until return to play were collected on all patients.

Arthroscopic Procedure

Hip arthroscopy was performed by a senior surgeon with the patient in a supine position as described by Byrd.[28] The central compartment was addressed first in all cases. An interportal capsulotomy was created in all cases to fully visualize and address the intra-articular and extra-articular sources of impingement. A rim osteoplasty was performed to correct cephalad retroversion and eliminate focal rim impingement lesions as assessed by labral pathology and confirmed with intraoperative fluoroscopy. Labral refixation was performed if tissue quality and tear pattern were amenable to repair and the labrum was not ossified. Anchors were placed 2 mm from the margin of the rim, and a non-everting mattress stitch was used. The femoral osteoplasty was performed in the peripheral compartment after removal of traction and gentle hip flexion of approximately 30° to 40°. A T-capsulotomy along the anterior femoral neck was performed in almost all cases to improve proximal-distal and medial-lateral visualization of the entire cam lesion and to ensure optimal restoration of offset in all safely accessible locations between the superior and inferior retinacular (epiphyseal) vessels. The T-capsulotomy was repaired at the conclusion of the procedure in all cases. Internal and external rotation of the leg improved access to the lateral and medial head-neck junctions, respectively. In cases of large superior or posterosuperior cam lesions, access was improved with leg extension and/or reapplication of traction. Intraoperative fluoroscopy was used to confirm restoration of offset on the extended-neck lateral radiograph and proximal-distal correction from the physeal scar to the intertrochanteric line (Fig 3). A dynamic assessment of clearance with direct hip flexion and internal rotation was performed in all cases.

RESULTS

The mean age of the professional athletes at the time of surgery was 31 years (range, 19 to 35 years). Of the patients, 32% (12 of 38) had previously undergone AP surgery by an outside referring general surgeon, and 1 of these underwent AP surgery concomitantly with surgical treatment of FAI. Three patients underwent AP and FAI surgery within 1 month's time. Most other patients underwent a trial period of returning to play after AP surgery to assess the absolute need for surgical intervention for the symptomatic FAI. None of these athletes was able to return to his previous level of competition after isolated AP surgery. However, 39% (15 of 38) had AP symptoms that resolved with FAI surgery alone. Of the 38 patients, 36 returned to their previous level of play, and all 12 patients with combined pubalgia and FAI surgery were able to return to professional competition. The mean time between arthroscopic surgery and return to play was 5.9 months (range, 3 to 9 months).

Arthroscopic Treatment of FAI

Of the athletes, 25 (65%) were treated for combined acetabular and proximal femoral deformity. Eight athletes (21%) were treated for a loss of femoral offset, and 5 athletes (13%) were treated for focal rim impingement lesions. All athletes had anterosuperior labral tears. Labral refixation was performed after rim trimming with suture anchors (mean of 3.5 anchors per patient [range, 3 to 5 anchors]) in 6 patients (15.7%). The remaining patients underwent capsular elevation, rim recession, and labral advancement. Concomitant additional procedures included adductor longus release (n = 1), partial psoas release (n = 1), and chondroplasty with microfracture of a cam delamination lesion (n = 1). Adductor release was performed for symptomatic athletic groin pain localized to the adductor longus tendon. One patient underwent revision arthroscopy consisting of loose body removal, debridement of scar tissue, and revision cam decompression. This patient was a football player who

Figure 3. (A) Intraoperative arthroscopic image of significant, unstable anterosuperior labral tear. (B) Rim recession is performed to eliminate the focal rim impingement lesion, with debridement of the degenerative anterosuperior labral tear. (C) A T-capsulotomy is performed to provide extensile exposure of the femoral-offset deformity. (D) Femoral osteoplasty is performed to restore the normal head-neck offset. Care is taken to confirm correction circumferentially and in a proximal-distal orientation along the femoral neck. (E) The T-capsulotomy is repaired in a side-to-side fashion after femoral offset has been restored.

had not previously undergone AP surgery and was not able to return to play.

DISCUSSION

The purpose of our study was to highlight the frequent overlap of AP and FAI diagnoses and to show the frequency of concomitant AP and FAI symptoms. We hypothesized that some elite athletes may manifest AP symptoms due to compensatory stresses from FAI and that these symptoms may resolve with surgical correction of FAI. In a consecutive series of 38 professional athletes treated for symptomatic FAI, we identified 12 (32%) who had undergone previous AP surgery. Interestingly, these 12 patients were not able to return to play after isolated AP surgery. After the additional treatment of FAI, however, all 12 patients were able to return to their previous level of professional sport. The remaining 24 patients who were able to return to play improved after surgical treatment of FAI alone, 15 of whom had AP symptoms that resolved with isolated treatment of their hip pathology. Our findings show that in a select group of high-performance athletes, FAI and AP symptomatology and diagnoses may overlap; having a high level of suspicion is essential to correctly diagnose both pathologies and not overtreat. With successful diagnosis and treatment, one can reliably return such professional athletes to their previous level of competition.

It is important to note that in those athletes requiring both AP and FAI surgery, the hip pathology was diagnosed at presentation to the general surgeon, and surgery to address this problem was planned to follow AP surgery. Many underwent short trials of returning to play after the AP surgery to determine the absolute necessity for subsequent surgical intervention for treatment of the FAI.

Adequate femoral head-neck offset prevents contact between the femoral neck and acetabular rim within a normal ROM. However, with increased bone volume at the femoral head-neck junction or with focal or global acetabular overcoverage (as seen with pincer-type FAI), insufficient clearance mechanically limits terminal ROM in multiple planes.[17,18] Although the specific deficiencies in motion are correlated with the location of deformity, FAI has typically been shown to decrease maximal hip flexion, internal rotation, and abduction.[17] Moreover, internal rotation decreases with increasing flexion and adduction.[17]

When the functional ROM required to compete in sports is greater than the physiologic motion allowed by the hip, a compensatory increase in motion may be provided by the lumbar spine, sacroiliac joint, pubic symphysis, and posterior hip subluxation. Subsequently, alterations in the mechanics of the hip joint due to underlying FAI may lead to changes in the dynamic muscle forces across the pelvis. The result is excessive strain at these joints and on the muscles that attach to them. In select patients, treatment of the cam or rim impingement lesion may restore sufficient motion to restore joint mechanics to a more physiologic state. The muscles most typically affected by dynamic impingement include the adductor longus, proximal hamstrings, abductors, iliopsoas, and hip flexors.[29]

Patients with FAI may adopt an alternative motion strategy, recruiting different muscles, with an alteration in hip and pelvic biomechanics occurring even during gait.[30] During level gait, cam FAI causes a decrease in peak hip abduction and total frontal ROM, slight reduction in sagittal hip ROM, and attenuated pelvic mobility in the frontal plane.[30] It seems unlikely that these altered motions result from mechanical limitations or bony contact as would occur at the extremes of motion. This suggests a soft-tissue component to FAI that is adaptive in nature to reduce hip pain during ambulation.[30] Limited sagittal pelvic ROM has also been shown in patients with FAI as compared with control subjects; moreover, patients with FAI could not squat as low as the control group.[18] Together, these findings may support compensatory or adaptive changes in pelvic motion and periarticular musculature due to FAI that may precipitate AP symptoms. This explanation is supported by the results of our study, in that 39% of athletes with concomitant pubalgia and FAI symptoms had a complete resolution of pain and dysfunction with FAI surgery alone.

In the high-performance athlete, restriction of terminal flexion and internal rotation at the hip joint may result in secondary abnormal motion of the hemipelvis. This motion may be responsible for injury to the posterior inguinal wall, rectus abdominis, and adductor musculature associated with a sports hernia.[13] In a recent study of hip injuries in National Football League players, Feeley et al.[31] found that the most common type of hip injury was muscle strain, followed by contusion, intra-articular injury, and sprain. Although these injuries may occur in isolation, a "sports hip triad" has been described, consisting of a labral tear, adductor strain, and rectus strain.[31] Therefore intra-articular pathology, such as FAI, may be implicated in exacerbating muscle injuries around the pelvis in athletes. Proximal hamstring tendinitis, rectus femoris avulsions, and psoas tendinitis are other causes of groin pain that may have a similar associa-

tion with FAI.[20,31,32] As with all muscle injuries, prevention is the key, consisting of preseason stretching, balance, and ROM exercises. Treatment of muscle injuries consists of rest, ice, physical therapy, and ROM exercises. Injections into the adductor enthesis have been described by Schilders et al.,[33] with success in both competitive and recreational athletes. Surgery has been described for the treatment of recalcitrant proximal hamstring and iliopsoas tendinitis.[31,32]

Larson et al.[34] recently published an article evaluating the results of surgical treatment of athletes with associated intra-articular hip pathology and extra-articular AP, further supporting the not infrequent overlap of these 2 diagnoses. They followed a series of 37 hips (mean patient age, 25 years) that were diagnosed with both symptomatic AP and symptomatic intra-articular hip joint pathology. Hip arthroscopy was performed in 32 hips (30 cases of FAI treatment, 1 traumatic labral tear, and 1 borderline dysplasia). Of 16 hips that had AP surgery as the index procedure, 4 (25%) returned to sports without limitations and 11 (69%) subsequently had hip arthroscopy at a mean of 20 months after pubalgia surgery. Of 8 hips managed initially with hip arthroscopy alone, 4 (50%) returned to sports without limitations and 3 (43%) had subsequent pubalgia surgery at a mean of 6 months after hip arthroscopy. Thirteen hips had AP surgery and hip arthroscopy at 1 setting. Concurrent or eventual surgical treatment of both disorders led to improved postoperative outcome scores ($P < .05$) and an unrestricted return to sporting activity in 89% of hips (24 of 27).

Limitations of our study include those inherent to a retrospective study and to a relatively small case series. The small series is comparable, however, to similar published series documenting hip pathology in professional athletes.[7,34,35] Furthermore, no objective outcome measurements were used; instead, return to play was the final outcome assessed. Although objective outcome measures would have strengthened the follow-up data, current outcome instruments such as the modified Harris Hip Score have not yet been validated for use in high-level athletes and may lead to an underestimation of debilitation in high-performance athletes, with a shown ceiling effect.[35] We believe that return to play, however, is an appropriate endpoint for analysis of success of any surgical intervention in this subgroup of patients. There is also an inherent selection bias involving the study of professional athletes. These patients have financial incentives to return to competitive play and are possibly less likely to report symptoms and complications that would prevent a return to play. Nevertheless, these patients' participation in physically demanding professional sporting activities was possible after surgical intervention for FAI and/or AP.

In summary, surgical treatment of FAI may result in resolution of all symptoms, because abnormal restriction in terminal hip motion due to FAI may precipitate compensatory stresses that weaken the posterior inguinal wall and place excessive strains on the musculature around the hip and hemipelvis. In certain cases surgical treatment of both conditions may be necessary to facilitate a successful return to professional competition.

CONCLUSIONS

There is a high incidence of symptoms of AP in professional athletes with FAI of the hip. This study draws attention to the overlap of these two diagnoses and highlights the importance of exercising caution in diagnosing AP in a patient with FAI.

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