The Prevalence of Radiographic Hip Abnormalities in Elite Soccer Players

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The Prevalence of Radiographic Hip Abnormalities in Elite Soccer Players

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Background: Hip injuries, both intra- and extra-articular, are becoming a more commonly recognized, diagnosed, and treated injury in athletes of all competitive levels. Our goal is to establish a previously undefined value in this athletic population—the prevalence of radiographic hip abnormalities in elite soccer athletes.

Purpose: To provide a foundation for the future body of literature regarding hip pathologic abnormalities and ''at-risk'' hips in athletes of all ages and levels of participation.

Study Design: Descriptive epidemiology study.

Methods: We retrospectively reviewed the anteroposterior pelvis and frog-leg lateral radiographs of 95 elite male and female soccer players to determine the prevalence of hip abnormalities. Athletes with a history of hip or groin injuries were included. Multiple radiographic parameters were used to assess the presence of cam and pincer-type femoroacetabular impingement. Measurements were conducted by a blinded, sports medicine fellowship–trained orthopaedic surgeon with experience in treating hip disorders.

Results: In total, 72% (54/75) of male and 50% (10/20) of female players demonstrated some evidence of radiographic hip abnormality. Cam lesions were present in 68% (51/75) of men (76.5% [39/51] bilateral involvement) and 50% (10/20) of women (90% [9/10] bilateral involvement). Pincer lesions were present in 26.7% (20/75) of men and 10% (2/20) of women. The average male alpha angle overall was 65.6°. Cam-positive hips averaged 70.7°. The average female alpha angle overall was 52.9°, with cam-positive hips averaging 60.8°.

Conclusion: The prevalence of radiographic hip abnormalities in elite soccer athletes is considerable, particularly in young male athletes. The establishment of the prevalence of these findings represents the first step in identifying the relationship between radiographic abnormalities and injuries of the hip and groin in athletes.

Keywords: femoroacetabular impingement; FAI; hip injuries; soccer; elite athletes

Over the course of the past decade, the recognition, diagnosis, and treatment of injuries of the hip region have increased dramatically. Athletes participating in ice hockey, soccer, and rugby are at highest risk for this type of injury.‡ Injuries that have received the most recent focus of attention include adductor injuries, sports hernias, and femoroacetabular impingement (FAI). Femoroacetabular impingement of the hip joint has been identified as a major cause of hip pain, reduced range of motion (ROM), and decreased performance in the athlete.[23,37] This decrement in function and performance is likely secondary to the associated chondral and labral damage intrinsic to the pathological process.

Despite the increased awareness of FAI, Burnett et al[5] have reported that the average time for an athlete to receive an accurate diagnosis from the time of injury was 21 months and required evaluation by 3.3 different health care providers. This suggests that although significant investigational and clinical educational efforts are currently under way, a mainstream awareness and thorough understanding of the disorder are still lacking. The purpose of this study is to begin to establish a foundation of knowledge for the greater understanding of FAI by identifying the prevalence of radiographic hip abnormalities in a cohort of professional soccer athletes.

MATERIAL AND METHODS

At the time of the 2008-2009 preseason entrance physical examinations, all potential roster members from 2 Major League Soccer (MLS) teams, the US Men's National Team (MNT), and 1 Women's Profession Soccer (WPS) team were evaluated. No explicit exclusion criteria were applied, so the study included players with a history of

‡References 9, 15, 18, 19, 22, 24, 26, 30, 34.

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TABLE 1
Demographic Breakdown of Players[a]

	n	Age, y, Mean (SD)	No. of Years Playing Professional Soccer, Mean (SD)	History of Any HGI, No. (%)	Average No. of Injuries in Athlete With at Least 1 Injury	Surgery for HGI, No. (%)
Male	75	25.8 (4.4)	5.9 (4.4)	41 (54.7)	1.4 (56 total HGI)	26 (46.4)
Female	20	23.8 (2.3)	1.1 (1.6)	5 (25.0)	1.2 (6 total HGI)	0
Total	95	25.4 (4.2)		46 (48.4)	1.3 (62 total)	26 (41.9)

[a]History of hip or groin injury (HGI) includes strains, contusion, intra-articular injuries, groin injuries, or avulsions.

hip or groin injuries. All data gathered were routine for preseason entrance examinations, and the MLS provided written approval for the study; institutional review board (IRB) approval was also obtained. Seventy-five male and twenty female professional soccer athletes were assessed (Table 1). Each athlete underwent a radiographic series for routine screening, including anteroposterior (AP) pelvis and frog-leg lateral radiographs of both hips. All radiographs were performed by experienced and certified radiology technicians and reviewed by a qualified orthopaedic surgeon for image quality and adequacy. Films were determined to be acceptable if the following criteria were met. On AP radiograph: comparable obturator foramen rotation was present and the coccyx was centered over and measured 2 to 4 cm above the pubic symphysis. On frog-leg lateral: the anterior and posterior femoral head-neck junctions were clearly definable. Radiographs of all examined players were reviewed by a blinded, sports medicine fellowship–educated orthopaedic surgeon with radiographic and arthroscopic hip training to assess for evidence of abnormalities. Specific measurements suggesting cam and/or pincer morphologic changes were taken of each hip documenting the alpha angle and/or presence of a crossover sign.

Crossover sign determination was performed on AP pelvis radiographs. Lines representing the anterior and posterior acetabular walls were traced out. Any overlap between the anterior and posterior wall lines was deemed a positive finding. Cam lesions were defined as the presence of the following signs on frog-leg lateral hip radiographs: excessive bone formation at the femoral head-neck junction, loss of normal femoral head sphericity, or flattening of the femoral head-neck offset or an alpha angle >55°. Pincer lesions can be suggested on plain radiographs by many signs, including coxa profunda, protrusio acetabuli, reduced extrusion index, and an acetabular index <0.[32] However, for the purpose of this study, the most reliable objective sign and the only sign required for a positive diagnosis of a pincer deformity was a crossover sign or figure-8 configuration. An abnormal radiograph was defined as any radiograph with either cam or pincer findings.

Alpha angles were measured on the frog-leg lateral view by using a radiographic computer goniometer (Impax PACS Imagining System; Afga Healthcare Corporation, Greenville, South Carolina). For each measurement, a spherical computer template was best-size matched to the spherical contour of the femoral head. The femoral head center point was established. At the first superolateral point where the bony contour diverged from the spherical template, a line was drawn to the center point of the femoral head. A second line was drawn from the center of the femoral head to the midpoint of the femoral neck. The subtended angle between these 2 lines was measured as the alpha (α) angle[25] (Figure 1).

Last, in a separately presented article, we reviewed the injury history for the same athletic population at the time of the radiographic screening (A. Dietz, H.J. Silvers, M.B. Gerhardt, D.A. Watanabe, and B.R. Mandelbaum, 2011). The data obtained from that study were referenced for a more complete presentation of the population demographics.

RESULTS

The overall average age of the athletes involved in the study was 25.4 ± 4.2 years. The average age for men was 25.8 ± 4.4 years and for women, 23.8 ± 2.3 years. The average number of years playing professional soccer for men was 5.9 ± 4.4 years (men with any hip/groin injury history = 5.7 ± 4.0 years and men without any hip/groin injury history = 5.3 ± 4.7 years). The average number of years playing professional soccer for women was 1.1 ± 1.6 years (women with any hip/groin injury history = 0.2 ± 0.44 years and women without any hip/groin injury history = 1.3 ± 1.7 years) (Table 1). Among the male athletes, 41 of 57 (54.7%) had a history of prior hip or groin injuries, as reported in detail elsewhere (A. Dietz et al, 2011). Among the female athletes, 25% had such a history.

Seventy-two percent (54/75) of men and 50% (10/20) of women had some evidence of radiographic hip abnormality consistent with FAI. Cam lesions were present in 68% (51/75) of men, with 76.5% (39/51) of the cam-positive men having bilateral hip involvement. Cam lesions were identified in 50% (10/20) of women, with 90% (9/10) of the cam-positive women demonstrating bilateral hip involvement. Pincer lesions were present in 26.7% (20/75) of men, with 80% (16/20) showing bilateral involvement. Pincer lesions were present in 10% (2/20) of women, with 100% (2/2) demonstrating bilateral findings (Table 2).

The overall average male alpha angle was 65.6°, with the normal alpha angle considered to be <55°.[1,3,5,28] Cam-positive men showed an average alpha angle of 70.7° versus 50.3° in cam lesion–negative men. Men with any positive hip radiographic findings showed an average alpha angle of 68.0° versus 50.0° in men with no positive radiographic findings. The

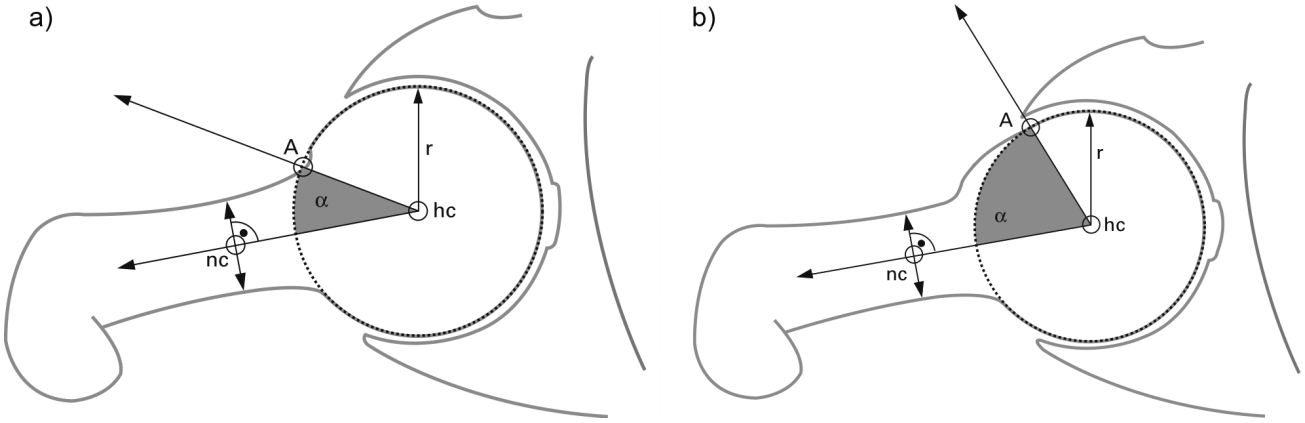

Figure 1. Diagram showing the construction of angle α. Point A is the anterior point where the distance from the center of the head (hc) exceeds the radius of the subchondral surface of the femoral head. α is then measured as the angle between A-hc and hc-nc, with nc being the center of the neck at the narrowest point. (a) A hip in a normal subject and (b) a typical deformation. (Reproduced with permission from Nötzli et al.[25])

TABLE 2
Distribution of Athletes With Cam/Pincer Lesions

	n	Cam, No. (%)	Bilateral Cam, No. (%)	Pincer, No. (%)	Bilateral Pincer, No. (%)	Any Femoroacetabular Impingement, No. (%)
Men	75	51 (68.0)	39/51 (76.5)	20 (26.7)	16/20 (80.0)	54 (72.0)
Women	20	10 (50.0)	9/10 (90.0)	2 (10.0)	2/2 (100.0)	10 (50.0)
Total	95	61 (64.2)	49/61 (80.3)	22 (23.2)	18/22 (81.8)	64 (67.4)

TABLE 3
Alpha Angle Differences Among Gender and in the Presence or Absence of a Cam Deformity

	Average α Angle, deg	Cam (+) α Angle, deg	Cam (–) α Angle, deg	Any Femoroacetabular Impingement α Angle, deg
Men	65.6	70.7	50.3	68.0
Women	52.9	60.8	47.5	58.9

overall average female alpha angle was 52.9°. Cam lesion–positive women showed an average alpha angle of 60.8° versus 47.5° in cam lesion–negative women. Women with any positive hip radiographic findings showed an average alpha angle of 58.9° versus 46.8° in women with no positive radiographic findings (Table 3). With regard to other radiographic findings, 21.3% (16/75) of men and 5% (1/20) of women had identifiable groin hernia repair mesh visible. This was found bilaterally in 50% (8/16) of men and 100% (1/1) of women with this finding. Os acetabuli and symphyseal osteoarthritic changes were found at a rate of 10.7% (8/75) and 16% (12/75) in men and 5% (1/20) and 25% (5/20) in women, respectively.

DISCUSSION

The goal of this study was to establish the previously undefined prevalence of radiographic hip abnormalities in a high-risk, professional cohort of soccer players. The prevalence rates and data obtained in this radiographic analysis resonate that the previously comprehended notion that hip and groin injury, FAI in particular, continues to be underrecognized. The prevalence rates of radiographic abnormalities, 72% in men and 50% in women, were significantly higher than anticipated by the authors. Cam lesions represent a large subset of these pathological anatomic findings, affecting 68% (51/75) of men (bilaterally in 76% [39/51]) and 50% (10/20) of women (bilaterally in 90% [9/10]). This higher incidence of bilateral findings brings into question the causes of these hip abnormalities. Is this the cumulative effect of a competitive career of early soccer sport selection, a decrease in cross-training or loss of multiple sport participation, repetitive microtraumas to the hip joint, or are these "at-risk" hip joints anatomically predisposed from some level of normal morphological variation of head-neck offset and acetabular version? As many researchers have currently espoused, a multifactorial

explanation is likely involved.[11,22] Our data also indicated a dramatically greater prevalence of higher alpha angles in men (averaging 65.6°) versus women (52.9°) (Table 3). This result has been similarly found in other series[15] and further confirms the clinical thoughts from other authors that cam lesions are a focal problem for athletic young males.[2,8] The difference between genders is not well understood at this time.

Two recent publications evaluated the presence of radiographic hip abnormalities in asymptomatic populations.[16,31] Hack et al[16] looked at an asymptomatic population of 200 volunteers with no history of hip problems or surgery. The evaluation was performed with the use of magnetic resonance imaging (MRI), and the alpha angle threshold was set at 50.5°. Correlation with internal rotation of the hip at 90° of flexion at the time of examination was also performed. They demonstrated a prevalence of cam shape in 14% in at least one hip. This is significantly less than the 68% and 50% cam deformity, respectively, in male and female professional soccer players in our series. Likewise, Silvis et al[31] used MRI to evaluate the hips and common adductor/rectus findings in 39 asymptomatic elite hockey players. They demonstrated a prevalence of significant hip radiographic findings in 64% of the athletes and common adductor-rectus abdominus findings in 36%. An abnormal alpha angle (>55°) was measured in 31% (12/39). Interestingly, the Hack et al[16] study evaluating nonathlete volunteers demonstrated a much lower prevalence of subjects with cam shape than the Silvis et al[31] study examining the hips of asymptomatic high-level athletes. The latter coincides with the prevalence of hip disease in our study of soccer players. In addition, the current study and the study by Silvis et al used an alpha angle cutoff of 55°, in contrast to the Hack et al study, which used a cutoff of 50.5°. It could be surmised that by using a lower alpha angle cutoff, you presumably would capture a higher incidence rate. This, interestingly, was not the case in the Hack et al study, supporting the notion that elite athletes are potentially at higher risk for hip morphologic changes. Furthermore, a study published by Brophy et al[4] measured the activity of the hip and knee musculature during a kicking mechanism of soccer. The researchers found that the iliacus mean muscle activation in the dominant kicking leg was 123% versus 34% of maximal voluntary isometric contraction ($P = .0007$) compared with the stance limb. This muscle activity imbalance can lead to an anterior rotation of the ilium, ostensibly increasing compressive forces in the anterior portion of the hip joint, a common place for joint injury. The use of biomechanical loading and electromyography (EMG) research will be critically important as we continue to devise injury prevention mechanisms to decrease the incidence of hip and groin injury in the athletic population.

Traumatic intra-articular injuries can result from acute injury such as hyperabduction, direct hip impact, and joint subluxation or dislocation. Certain positions and motions have been purported as risk factors for hip injury, in particular, flexion combined with internal rotation (ice hockey goalie stance).[28,29] Atraumatic hip injury is more poorly comprehended. The interrelation of hip pathoanatomy such as developmental hip dysplasia (DDH), cox profunda, slipped capital femoral epiphyses (SCFE), and others to FAI need further research. Byrd and Jones[6] reported improved results in patients with a specific traumatic event at onset of their hip symptoms. Furthermore, they have proposed an unidentified predisposition to injury that may be responsible for this outcome differential. The "at-risk" hip secondary to anatomic or mechanical variations such as hip mechanical changes from cam/pincer lesions has been broached by Johnston et al.[17] The concept also includes the predisposition of a mildly injured hip to rapidly degenerate to an irrevocable degree of injury. Better understanding of this pathologic process benefits not only upper-level athletes but also all spectrums of society. Ganz et al,[14] Beck et al,[1] and others[12,20,33] have demonstrated the lifetime effect of this pathology by identifying FAI as a cause of primary hip osteoarthritis. Further investigations into the pathoanatomic, pathophysiological, and pathomechanical contributions to FAI need to be undertaken to improve our ability to treat this problem and generate screening and prevention programs.

With respect to other radiographic findings, the hernia repair mesh identified in 21.3% (16/75) of men and 5% (1/20) of women further identified this cohort's risk for hip and groin injury. The incidence and prevalence of sports hernia in this population are unknown. However, the data from this study likely underestimate the number of affected athletes due to the number of players undergoing primary hernia repair as opposed to hernia mesh placement. Because the symptoms for sports hernia and hip pathologic abnormality often overlap and/or coexist, we must also consider the possibility that they were treated for a misdiagnosed sports hernia.

Cross-table or frog-leg lateral radiographs have been identified as reliable for the measurement of head-neck offset, the alpha angle of Nötzli, asphericity, and multiple other radiographic hip parameters.[7,17,21,24,25] Despite this reliability, a recognized limitation of this study is that magnetic resonance arthrography (MRA) is rapidly becoming the modality of choice for complete evaluation and assessment of this pathologic process. This is secondary to its superior ability to detect labral and articular pathologic changes with 90% sensitivity and 91% accuracy.[13] In addition, the frog-leg lateral has been shown to underestimate asphericity and alpha angle relative to MRA.[10] This suggests that the prevalence and degree of asphericity and alpha angles may actually be higher.

We recognize that this study has many limitations. Although the athletes were asymptomatic at the time that the radiographs were obtained, some athletes did have a history of hip or groin complaints. Although we did not include these data within this study, it has been analyzed in male athletes and submitted as a separate publication (A. Dietz et al, 2011). It is our belief that a true cross-sectional observation of this specific population needs to be performed and reported. Second, the radiographs were reviewed by only 1 orthopaedic surgeon, which is limited with respect to interobserver reliability of the radiographic findings. Last, this is a small sample size of a very specific population and does not fully represent the population as a whole.

CONCLUSION

The prevalence of radiographic hip abnormalities in elite soccer athletes is considerable, particularly in young males. This information is the first step in a global pursuit of establishing a greater understanding of FAI, including the prevalence in multiple ages, genders, age of specificity of sport, and participation levels. A clearer definition of the pathogenetics, pathomechanics, and the natural history of these injuries will add to our knowledge base to eventually culminate in the creation of an optimal screening and prevention program for the protection of athletes of all ages across a multitude of sports.

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