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Hip Injuries in the Contact Athlete

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Despite being relatively uncommon when compared to injuries to the ankle and knee, hip injuries in the contact athlete account for 5%-6% of all athletic-related injuries with increasing prevalence over the last decade. Athletic hip injuries represent a spectrum of often overlapping intra- and extra-articular disorders with the potential to cause significant disability and time lost from sport. Advancements in imaging modalities, arthroscopic instrumentation, and surgical techniques have improved diagnostic capabilities and treatment outcomes of athletic hip injuries. Furthermore, increased screening and better recognition of the role of femoroacetabular impingement on the development of intra-articular hip pathology and instability has provided physicians with a treatable risk factor deterring further hip disorders. This chapter provides physicians with a brief overview of commonly encounter hip injuries in the contact athlete, namely: muscle strains, contusion, labral injuries, and hip instability secondary to dislocation or subluxation in the setting of femoroacetabular impingement, as well as the previously described "sports hip triad."
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Introduction

When compared to athletic injuries to the knee and ankle, hip injuries are relatively uncommon, comprising only 5%-6% of all sports-related injuries.[1-4] Injuries may involve intra-articular, extra-articular, or a combination of structures within and around the hip as a result of acute trauma or chronic overuse.[3,5,6] As such, the causes of hip pain in the athlete are often multifactorial while the complex anatomy and biomechanics about the hip can make the diagnosis and management of hip injuries in the contact athlete challenging.[4,7]

The hip joint withstands forces comparable to 6-8 times body weight during walking and running, with significantly higher forces experienced during sporting activities.[8] As such, a significant degree of stress is required to injure the hip in healthy athletes. Athletes participating in contact sports are at elevated risk for hip injuries due to the high impact loading, axial and torsional forces applied across the soft tissues, and bony structures about the hip during competition.[2,9] In particular, football athletes have been found to be susceptible to axial and rotational loads during competition approaching up to 12 times body weight.[10] Historically, hip injuries in athletes presented a diagnostic dilemma, as hip injuries were frequently overlooked or misdiagnosed, resulting in delayed recognition, risking additional injury, and prematurely ending athletic careers.[2,5] However, refinements in physical examination techniques and advancements in imaging modalities, particularly magnetic resonance imaging (MRI), have resulted in an improved understanding of athletic hip injuries.[5,6] Combined with the increased recognition of the contribution of abnormal bony anatomy typical of femoroacetabular impingement (FAI) in certain athletes to the development of intra-articular pathology and instability, hip injuries have become increasingly recognized over the last 15 years as a significant source of time loss from competition and disability in the contact athlete.[11,12]

The prevalence, epidemiology, and outcome following the treatment of hip injuries in contact athletes have been reported in athletes participating in American football,[4] ice hockey,[13-15] soccer,[16-18] rugby,[19] and basketball.[20] Commonly reported hip injuries include muscle strains and

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contusion, as well as intra-articular injuries involving the labrum, along with associated instability secondary to hip dislocation and subluxation.[3] As such, the purpose of this chapter is to provide an overview of commonly reported injuries encountered in the contact athlete presenting with hip or groin pain.

Strains

Muscle strains about the hip are the most commonly reported injuries sustained to the hip in contact athletes. Muscle strains have been reported to account for 59% of all hip injuries in American football athletes,[4] 57% of all hip injuries in professional basketball athletes,[20] and 23% of all muscle injuries in professional soccer athletes.[18] Muscle strains are commonly sustained to the adductor muscle complex, composed of the adductor longus, adductor magnus, and adductor brevis muscles, including the gracilius, obturator externus, and pectineus.[2] The adductor longus has traditionally been identified as the most common source of injury and symptomatic discomfort in athletes sustaining muscle strains.[21] Injuries are reported to occur primarily during sprinting and cutting, in which eccentric muscle contractions at the myotendinous unit or fibrocartilaginous insertion at the pubic bone occurs.[2] However, strains have been diagnosed in up to a third of contact-type mechanisms as well, namely blocking, tackling, and being tackled.[4]

Following injury, athletes generally complain of aching pain localized to the groin or medial thigh that is exacerbated with stretching of the adductors or resisted adduction.[2] Pain may be elicited with palpation at or near the pubic bone, while more distal tenderness is indicative of injuries to the myotendinous unit. The majority of injuries involve low-grade strains and partial tears, generally amendable to non-surgical treatment incorporating rest, ice and judicious use of anti-inflammatories to control hemorrhage and edema. Well-structured rehabilitation protocols involving activity modification in conjunction with gradually increasing hip range of motion, stretching, and strengthening exercises are generally employed.

Correction of predisposing factors, primarily muscle tightness, weakness or imbalances across the pelvis are critical, as athletes sustaining repeat muscle strains possess considerably longer return to play times when compared to their initial injury.[15] Tyler et al found that in a cohort of National Hockey League (NHL) athletes, preseason hip adduction strength was 18% lower in athletes who sustained adductor muscle strains when compared to uninjured athletes over 2 seasons.[15] The authors emphasis on the importance of preseason hip strengthening was verified in a subsequent study in which Tyler et al reported that athlete participation in a dedicated preseason hip strengthening program effectively decreased the incidence of hip strains over the course of 2 consecutive seasons.[22] Meanwhile, Arnason et al found that professional soccer athletes with a history of groin strains or limitations in leg abduction similarly experienced a higher rate of hip muscle strains over the course of a season.[23]

Injections to the entheseal pubic cleft into the adductor enthesis have proven successful in elite and recreational athletes with chronic pain and normal MRI findings; however, injections are less effective in athletes with more advanced adductor disease.[24,25] Athletes with complete ruptures of the proximal adductor longus generally require surgical reattachment.[2] However, Schlegel et al found that American football athletes with adductor longus ruptures were able to return to play in 6 weeks when treated nonsurgically when compared to 12 weeks in athletes treated surgically; however, long-term outcomes were not reported.[26] As such, no universal consensus currently exists regarding optimal management for athletes with complete adductor tears.

Contusions

Hip contusions or "hip pointers" have been reported as the second most common injury occurring in American football athletes, occurring most commonly as a direct result of contact injuries to the hip or iliac crest.[4] Contact injuries common occur during blocking, tackling, and collisions, as well as a result from a fall during activity.[4] Athletes typically complain of point tenderness, ecchymosis and occasionally muscle spasms about the affected area of the hip.[3] Significant injuries may result in associated subperiosteal, intramuscular or subcutaneous hematoma formation with the potential of placing pressure onto the adjacent femoral or lateral femoral cutaneous nerves.

Despite variations in management strategies, treatment focuses on minimizing swelling and bleeding with rest, compression and ice to preserve motion and decrease hematoma formation. Protected weight bearing on crutches with gradual stretching and strengthening of the muscles around the hip are generally employed. Use of local anesthetic injection may also allow for continued participation for in-season athletes. The majority of contact athletes recover quickly, returning to full activity at a mean of 5 days following injury.[4] However, more significant injuries with large hematoma with significant limitations in range of motion can be evacuated or aspirated if warranted.[3]

Intra-articular Lesions

Labral Lesions and FAI

Intra-articular injuries to the hip comprise only 5% of all reported hip injuries in athletes, but represent a significant source of pain and time lost from competition when compared to all other hip and groin injuries.[13,27] The acetabular labrum plays a critical role in maintaining joint stability, congruity, while effectively dissipating the mechanical stresses placed on the hip by acting as a load-sharing structure.[28] As such, labral injuries can effectively compromise the function of the labrum and expose the chondral surface of the femoral head and neck to injury.[29,30]

Athletes sustaining labral injuries generally complain of groin pain with limitations in range of motion secondary to

discomfort that may be accompanied by an audible or palpable click at the hip. Athletes are generally unable to recall a specific traumatic event; however, twisting or slipping may be reported.[3] Athletes sustaining intra-articular injuries classically describe a "C" shaped distribution of pain over the anterolateral hip.[31] On physical examination, anterior labral tears can be identified by reproduction of sharp pain with hip flexion, external rotation, and abduction followed by extension with internal rotation and adduction.[3] Meanwhile, posterior labral tears commonly result in the reproduction of pain with passive flexion and internal rotation with a posteriorly directed load.[32-34]

Recent data have demonstrated considerable overlap between labral pathology and the presence of underlying bony impingement secondary to FAI in athletes.[28,35-38] FAI consists of abnormal bony morphology at the femoral neck (cam lesion), acetabular rim (pincer lesion), or mixed (combined lesion), resulting in abnormal, repetitive abutment of the anterolateral femoral head-neck junction against the anterolateral acetabular rim.[38] FAI has been found to occur in high incidence in various elite contact athletes, including elite football,[39,40] ice hockey,[41] and soccer[42] athletes. Abnormal anatomic contact with subsequent loss of internal rotation secondary to impingement effectively increases the risk for intra-articular damage to the labrum and chondral surface, leading to injury and the potential for early onset osteoarthritic changes with continued injury.[38,43]

Due to the high prevalence of underlying FAI, all contact athletes with hip pain require evaluation and screening for potential underlying bony derangement. On physical examination, the flexion, adduction, and internal rotation test has been shown to be the most sensitive physical examination test to detect the presence of FAI.[28,31] Standard anteroposterior (AP) and lateral views of the injured hip should be obtained, along with a modified Dunn view (hip flexed at 90°, abducted 20°) to best delineate the presence of cam lesions on the femoral neck[31] (Fig. 1A and B). Further evaluation of labral pathology and chondral integrity is generally recommended using MRI.[44,45] While MRI arthrography has traditionally been utilized to provide diagnostic imaging of the intra-articular structures within the hip with high sensitivity and specificity for the detection of injuries,[46] recent advancements in MRI techniques without arthrography have resulted in reported detection rates for labral and cartilage defects equivalent to those using arthrography[44] (Fig. 2).

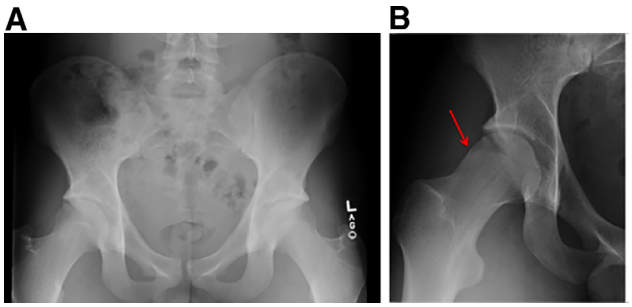

Figure 1 (A) Anteroposterior and (B) Dunn lateral radiographs demonstrating cam lesion of the right hip (red arrow). (Color version of figure is available online.)

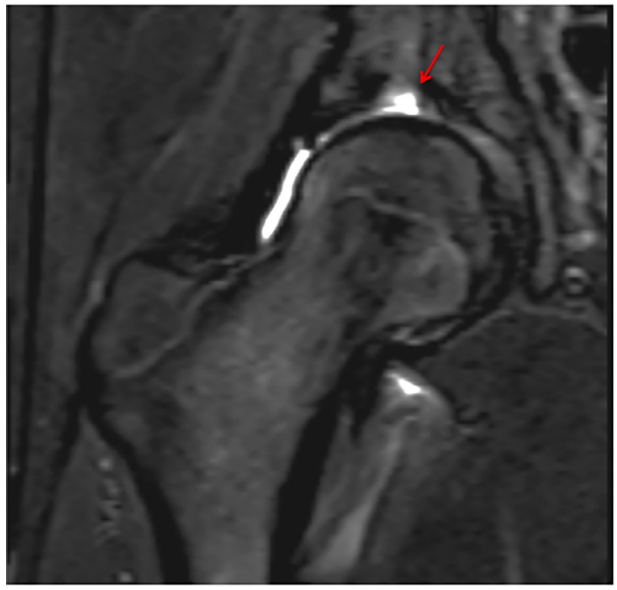

Figure 2 Magnetic resonance imaging of the right hip without contrast demonstrating complex labral tear (red arrow) with concomitant cam deformity. (Color version of figure is available online.)

Multiple risk factors have been identified predisposing contact athletes to FAI. Cam formation has been proposed as a potential structural adaptation to participation in high-impact sporting activities in adolescence during skeletal growth, when the skeleton is most susceptible to mechanical loading.[47,48] When compared to high impact sports, continued participation during growth has been shown to exacerbate the bony deformity over time, with Philippon et al reporting a significantly correlation between age and elevated alpha angles associated with cam deformity in youth ice hockey athletes that was not appreciated in age-matched athletes participating in low-impact sports.[49] In their prospective investigation of 67 asymptomatic collegiate football athletes, Kapron et al found that risk factors for FAI included increasing athlete weight and body mass index, both of which were found to be significantly correlated with elevated alpha angles, indicative of cam deformity.[40] The retrospective evaluation of 107 athletes (n = 123 hips) evaluated at the NFL Scouting Combine from 2007 to 2009 by Nepple et al found that despite not reaching statistical significance, cam prevalence and increased alpha angles were more common in athletes playing positions requiring greater hip flexion, namely linemen, tight ends, and linebackers.[45] Meanwhile, Feeley et al found that defensive athletes were the most commonly affected with hip injuries based on position.[4]

Athletes sustaining labral tears in-season may be able to return to play without immediate surgical intervention. Symptom control and nonsurgical management may consist of rehabilitation therapy to gradually improve hip flexibility and strength, while practicing sport technique modification to avoid pain and injury exacerbation.[31,50] Symptoms may also be well controlled for in-season with intra-articular corticosteroid injection delivered under ultrasound guidance.[4] In athletes with persistent symptoms resulting in diminished athletic performance, surgical intervention may be required.

The traditional treatment of intra-articular hip injuries using an open approach has been largely replaced with arthroscopic management, a minimally invasive approach allowing full visualization and treatment of multiple intra-articular injuries.[51] When compared to open management, hip arthroscopy has been shown to result in decreased recovery times with quicker return to sport[9,51-54] and high rates of patient satisfaction.[4,45]

In the setting of isolated, traumatic labral tears without concurrent chondral injury or impingement, athletes may be successfully treated with arthroscopic debridement alone vs repair or reconstruction in the setting of large irreparable tears.[55,56] However, in athletes with labral tearing with concurrent FAI, failure to treat the bony abnormality has been shown in multiple investigations to increase the risk of recurrent labral tearing requiring revision surgery, producing inferior outcomes.[10,52,57,58] This has led authors to conclude that failure to address FAI is effectively a contraindication to arthroscopic labral repair or reconstruction in athletes with concurrent pathologies.[10] As such, prior to any management, surgeons must be cognizant of the presence of any bony impingement, requiring removal via osteochondroplasty to ensure optimal outcomes.

FAI-Induced Hip Instability

Athletes experiencing symptomatic hip instability secondary to traumatic or atraumatic mechanisms may be predisposed to instability due to underlying FAI. The systematic review by Canham et al found that in 92 patients with hip instability following hip dislocation or posterior subluxation, 97% had evidence of FAI.[59] A proposed mechanism for FAI-induced hip instability involves anatomic conflict in the presence of pincer or anteriorly based cam lesion, effectively lever the femoral head posteriorly out of the acetabulum at the extremes of motion.[60] Biomechanical studies have further corroborated the phenomenon of impingement-induced instability in real time, showing evidence of subluxation occurring at extremes of hip motion in adult and professional dancers with FAI.[61-63] As such, in the presence of FAI, athletes may be predisposed to hip subluxation or dislocation with subsequent instability following even minor trauma. Manner et al reported on a 16-year-old male soccer athlete with FAI sustaining a posterior hip dislocation following a simple fall onto a flexed knee with 2 additional dislocation episodes occurring after initial closed reduction, eventually requiring surgical intervention.[64] Similarly reported low energy mechanisms resulting posterior hip dislocations during sport in athletes with FAI have been reported.[65] As such, athletes with reported instability episodes necessitate evaluate for the presence of impingement and advanced imaging to detect concomitant intra-articular defects to the labrum and cartilage, followed by arthroscopic management if instability persists following nonsurgical treatment.

Acute Hip Subluxation/Dislocation

While uncommon, hip instability secondary to acute traumatic hip dislocation has been reported in contact athletes.[66,67] While acute dislocations are rare, hip subluxation events likely occur more frequently than is recognized in contact athletes.[3] Acute hip dislocations require immediate attention and represent a surgical emergency, as insult to the vascular supply to the femoral head may result in avascular necrosis with significant long-term disability in the athlete. On-field management involves rapid evaluation, involving neurovascular examination due to concern for potential injury to the sciatic nerve or femoral neurovascular structures. With the majority of reported athletic hip dislocations occurring in the posterior direction, the affected leg generally appears shortened, in slight flexion, adduction and internal rotation. Meanwhile, anterior dislocations, comprising only 8%-15% of all traumatic dislocations, commonly present with the leg in external rotation, abduction and either flexion or extension.[3] While some athletes have reported spontaneous reduction of the hip following acute dislocations, the majority will require formal closed reduction due to the significant forces required to overcome the inherent stability of the hip.[68]

Athletes presenting with concern for potential dislocation with or without spontaneous reduction require urgent immobilization and transportation to an emergency room facility following initial rapid examination, where AP radiographs of the pelvis should be performed to confirm the presence of a persistent dislocated hip, in addition to identifying any concomitant fractures to the acetabulum, femoral head or femoral neck (Fig. 3). In the setting of a dislocated hip, attempted closed reduction should be performed following administration of intravenous anesthetic or general anesthesia to allow for pain control and muscle relaxation. Unsuccessful hip reduction, secondary to incomplete muscle relaxation, entrapped intra-articular bony fragments or an entrapped labrum, require urgent open reduction in the operating room.[69,70]

In athletes undergoing successful closed reduction, repeat neurovascular examination is critical, followed by computed tomography to confirm concentric reduction, while better defining the presence of any fractures to the

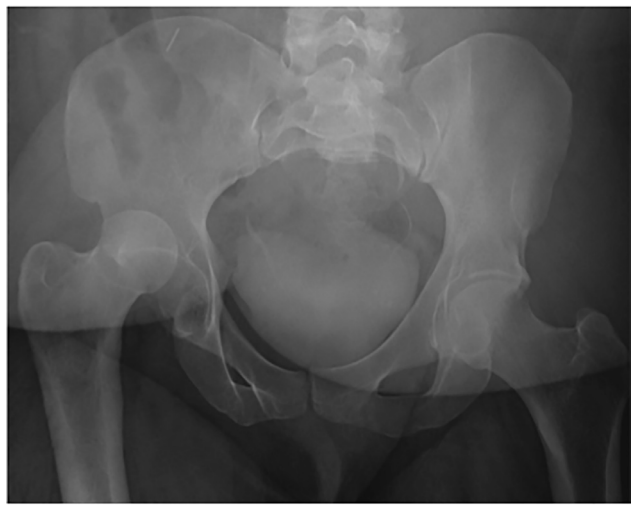

Figure 3 Anteroposterior radiograph demonstrating acute right posterior hip dislocation.

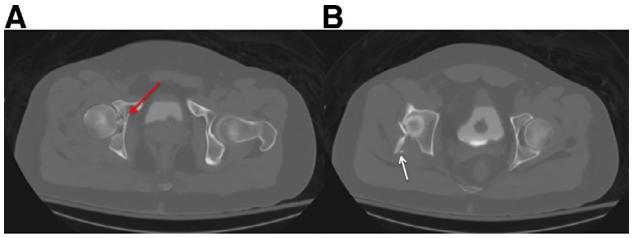

Figure 4 (A) Computed tomography axial images following closed reduction of right posterior hip dislocation demonstrating entrapped intra-articular fracture fragments (red arrow) secondary to (B) posterior acetabular wall fracture (white arrow). (Color version of figure is available online.)

femoral head, femoral neck or posterior acetabulum, while also evaluating for the presence of intra-articular loose fragment that may damage the chondral surface (Fig. 4A and B). In the setting of gross persistent instability following closed reduction, surgical management is warranted to restore the stability to the hip. For athletes with large posterior acetabular fracture resulting in persistent hip instability or fractures to the femoral head, an open approach is required to restore the bony architecture of the hip. Once athletes are stable, the ipsilateral knee should also be carefully evaluated due to concern for concurrent injury given the typical axial load placed along the femur leading to dislocation with further imaging obtained if warranted based on examination findings.

In the setting of hip dislocation without evidence of fracture or gross instability, athletes may be treated with a trial of nonsurgical management with partial weight bearing with crutches for 6-8 weeks, followed by gradual strengthening and range of motion. However, close follow-up is critical, as athletes with persistent hip pain with inability to advance with therapy and return to sport likely require further evaluation and imaging to determine the need for surgical intervention. Due to the high risk of vascular injury in the postinjury period to the femoral head, reported to occur between 6% and 40% of athletes following hip subluxation[71] and dislocation,[68] MRI should be obtained 3 months following injury to rule out the presence of osteonecrosis.[66,71]

Athletes with a single or multiple episodes of hip subluxation generally present without knowledge of an index traumatic event.[71] Episodes may be reported to occur in the setting of a simple fall onto a flexed knee with the hip adducted, forcing the femoral head posteriorly onto the rim of the acetabulum or secondary to an athlete braking quickly or pivoting. AP pelvis and Judet films should be obtained to rule out the presence of acetabular lip fractures, with advanced imaging including CT or MRI to better define the extent of bony or soft tissue injury, including femoral head contusion or labral tearing, if indicated. Treatment typically consists of protected weight bearing with crutches for a period of 6 weeks, followed by repeat MRI to detect for chondrolysis or avascular necrosis. Athletes may then proceed with gradual strengthening and stretching, with return to activities once painless-free range of motion is achieved.

Sports Hip Triad

As a result of the high axial and torsional loads imparted to the hip in contact athletes during competition, injuries may occur both inside and outside the hip joint. The association between intra-articular hip pathology and extra-articular soft tissue structures has been previously reported, leading to the moniker "sport triad," representing a combination of labral tearing with adductor and rectus strains in athletes.[4] The mixture of injuries to the adductor and rectus is commonly referred to as "core muscle injury" or "athletic pubalgia" or "sports hernia."[72,73] While the exact relationship between core muscle injury and associated labral tearing is unclear, Feeley et al proposed that athletes with injury to the pelvic musculature suggestive of core muscle injury are at increased risk for altered mechanics across the hip joint.[4] This may increase the risk of labral injury due to the high degrees of axial and rotational loads placed across the hip in contact athletes.[10] However, no definitive injury timeline of injury has been established regarding the sequence in which injuries occur.[4,74] Treatment of athletes focuses on gradually regaining flexibility and strength across the hip; however, operative management addressing all aspects of the "sports hip triad" may be necessary to allow full return to sport.

Conclusion

While hip injuries are relatively uncommon when compared to knee and ankle injuries in athletes, the spectrum of injuries encountered in the contact athlete require careful diagnosis and management to enable return to play. Hip strains and contusions are the most frequently encountered hip injuries in the contact athlete; however, intra-articular injuries represent a significant source of disability and time lost from competition. Athletes with hip pain require screening for underlying bony impingement from FAI which has been shown to be associated with the presence of labral pathology and likely causative factor in the development of hip instability. While the majority of hip injuries can be treated successfully using nonsurgical measures in the in-season athlete, athletes with persistent pain require further evaluation to determine the need for operative intervention, generally in the form of arthroscopic management. However, the acute hip dislocation in the contact athlete represents a surgical emergency necessitating immediate evaluation and treatment to prevent severe, long-term consequences.

Conflicts of Interest

DMK: No conflicts; MJS: Paid consultant for Smith & Nephew.

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