Initial Assessment and Management of Select Musculoskeletal Injuries: A Team Physician Consensus Statement

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Abstract

Musculoskeletal injuries occur frequently in sport during practice, training, and competition. Injury assessment and management are common responsibilities for the team physician. *Initial Assessment and Management of Musculoskeletal Injury—A Team Physician Consensus Statement* is title 23 in a series of annual consensus documents written for the practicing team physician. This statement was developed by the Team Physician Consensus Conference, an annual project-based alliance of six major professional associations. The goal of this document is to help the team physician improve the care and treatment of the athlete by understanding the initial assessment and management of selected musculoskeletal injuries.

Musculoskeletal injuries resulting from athletic activity represent a high proportion of a team physician's practice. This document will address select injuries, discuss the mechanism of injury, describe common clinical presentations, outline initial assessment, and illustrate options to initiate definitive treatment. It will aid the team physician when they first see the athlete with the goal to improve care. This may occur on the field, in the training room, or in the office with focus on initial assessment and management rather than subsequent treatment and rehabilitation.

Methodology

The Team Physician Consensus Conference (TPCC) has been led by the American College of Sports Medicine Clinical Sports Medicine Leadership committee for more than two decades. The TPCC was formed to create relevant, timely, and condensed resources specifically for the team physician working with athletes at every level of competition. An executive committee of medical and orthopedic team physicians from the Clinical Sports Medicine Leadership selects topics, creates an outline based on their collective experience of the topic, then leads a delegation composed of one to two representatives from each of six major professional medical organizations, including the American Academy of Family Physicians, the American Academy of Orthopedic Surgeons, the American College of Sports Medicine, the American Medical Society for Sports Medicine, the American Orthopedic Society for Sports Medicine, and the American Osteopathic Academy of Sports Medicine. Representatives are chosen by their organization based on their experience as team physicians with expertise in the topic area. The executive committee assigns select topics from the outline for the representatives who perform an evidence-based review of the existing literature. The outline is reviewed and modified by the executive committee and expert panel members, and they then formulate statements that are supported by the literature and best practices into a format of "essential" and "desirable" information that the team physician is responsible for understanding. "Essential" statements are information that every and any team physician must be responsible for understanding, whereas "desirable" statements are those that are ideal, in the setting where every resource is available. TPCC articles are intended to provide general recommendations but are not meant to be prescriptive. The executive committee along with select expert consultant(s) collate and review the document over the course of 12–14 months, culminating in an in-person 2-d meeting of the executive committee and consultant(s) to finish compiling the article into a rough draft. That meeting is followed by a 2-d meeting with all of the representatives during which the

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final article is completed. This is a facilitated process where all topics of the article are reviewed and exact wording is determined and agreed upon. Consensus in this TPCC was reached by unanimous agreement. The final documents are then reviewed and approved by the board of directors of all six participating organizations.

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Definition/Purpose

Musculoskeletal injuries occur frequently in sport during practice, training, and competition. Injury assessment and management are common responsibilities for the team physician. The goal of this document is to help the team physician improve the care and treatment of the athlete by understanding the initial assessment and management of selected musculoskeletal injuries. For the purposes of this document, the timing of the initial assessment may be on the sideline, in the training room, or the first office visit with an injured athlete. Topics are organized by mechanism of injury, clinical presentation, evaluation (including examination and imaging), nonoperative treatment options, operative treatment options (including indications, principles, and techniques), and other considerations, such as injury risk modification.

KEY POINTS

- Rate of recurrence in shoulder dislocations in youth athletes is high in collision/contact sports.
- The overhead throwing shoulder motion is a complex activity with contributions through the entire kinetic chain. Problems may present as a decline in both performance and injury.
- Excessive external workload (e.g., playing in pain, multiple teams, pitch loads, acute/chronic workload ratio) has been well established as a key component of the mechanism of injury in the shoulder and elbow as well as hip/groin apophyseal injuries. Workload management is advocated to modify injury risk.
- Hamstring injury is the most common noncontact muscle injury in several sports, including soccer, American tackle football, Australian-rules football, rugby, track and field, basketball, and other Olympic sports.
- Anterior cruciate ligament (ACL) injury alone is associated with future risk of osteoarthritis with or without surgical intervention. Nonoperative treatment is associated with risk of meniscal and chondral injury. Indications for surgery include gross symptomatic instability; desire to play a sport involving jumping, cutting, and pivoting; failure of nonoperative management; and prevention of future intra-articular injuries.
- Multimodal primary prevention programs have been shown to decrease the incidence of ACL and hamstring injuries.
- Groin pain can be categorized into two major musculoskeletal etiologies: 1) medial or inguinal groin pain resulting from extra-articular musculoskeletal structures (adductor-related, iliopsoas-related, inguinal-related) and pubs and 2) intra-articular hip-related groin pain in an athletic population as femoral acetabular impingement (FAI). FAI is not an injury but the most common cause of intra-articular hip pain in professional and recreational athletes.
- Musculoskeletal ultrasound is emerging as a diagnostic tool for several musculoskeletal injuries.

Types of Injury

Shoulder dislocation/subluxation

Symptomatic shoulder instability has two possible components: dislocation, complete disarticulation of the humerus and the glenoid, and subluxation, incomplete disarticulation of the humerus off the glenoid. Instability is further characterized by direction (anterior, posterior, inferior, or multidirectional), timing (acute, chronic, recurrent), and etiology (traumatic, atraumatic).

Males experience more dislocations than females. American tackle football and basketball are the highest-risk sports. The rate of recurrence is high in specific populations (younger age and collision/contact sports) (1,2). Up to 92% of young athletes may experience recurrence. A large majority of traumatic dislocations in sport are anterior (1).

Mechanism of injury

Anterior dislocation (forward and downward direction) can be the result of traumatic force, such as in contact/collision sports, with the arm in anterior flexion, abduction, and external rotation with application of force through the affected arm or a fall on an outstretched hand. With underlying instability, dislocation may be due to lesser force.

Posterior dislocation (backward direction) may result from trauma or soft tissue laxity, with the arm in forward flexion, adduction, and internal rotation. This is often seen in offensive lineman in American tackle football due to the forward flexed and internal rotation of the shoulder required to block.

Clinical presentation

Pain is acute and severe and is typically significantly reduced with joint relocation. With an anterior dislocation,

the affected arm most commonly presents in external rotation and abduction. Paresthesia and weakness may be present in the affected extremity. Fullness in the axillary region and prominence of the acromion are commonly observed. Range of motion (ROM) is significantly restricted. The clinical presentation is usually less pronounced with subluxation.

Evaluation/examination

On-field/training room initial assessment:

- History is often limited.
- Determining the mechanism of injury guides the initial management.
- Assess for concomitant injury (e.g., cervical spine, brachial plexus, fracture).
- Prerelocation imaging is not essential in the case of on-field relocation. Postrelocation radiographs should be obtained in follow-up of first-time dislocations.

Sideline/training room examination:

- Inspection of skin, position of arm, shoulder contour, sulcus sign, and comparison with contralateral shoulder may elucidate subtle asymmetries but not always possible.
- Evaluate ROM.
- Assess neurovascular status exam with particular emphasis on axillary nerve and distal pulses.
- Motor examination may be limited due to dislocation and pain.
- Repeat neurovascular exam if joint relocation is performed.

Initial office evaluation

Conduct a history, including:

- Hand dominance
- Mechanism of injury
- Time from current injury
- Previous instability events, including time of first dislocation
- Previous treatment
- Sports activity and intensity
- Generalized ligamentous laxity (GLL)
- Athlete's expectations, goals, and timeline for future sports activity

Office examination:

- Perform as outlined in sideline/training room examination.
- Examination of rotator cuff function, especially subscapularis
- Provocative testing with caution to include apprehension/relocation, load and shift, and anterior/posterior drawer.
- Evaluate to rule out multidirectional instability/generalized ligamentous laxity with Beighton score, including sulcus sign.

Imaging:

- Postrelocation radiographs should be obtained after every first-time dislocation to assess the position of the humerus on the glenoid and rule out fracture. At a minimum two views, including a true anterior–posterior (AP) and axillary or equivalent view must be obtained. Posterior dislocations are often missed on plain radiographs.
- Advanced imaging with magnetic resonance imaging (MRI) and computerized tomography (CT) is not routinely used after a first-time dislocation but may be considered in recurrent dislocations.
- The addition of contrast in an arthrogram can increase the visualization of pathology in a nonacute setting. MRI can also show contusion and subtle fractures at the glenoid not seen on plain radiographs. CT scan can be ordered if there is concern for glenoid fractures, such as Bankart fractures, and to assess glenoid morphology and possible bone loss, which may be a factor in the dislocation.
- Ultrasound is emerging technology for the diagnosis and management of shoulder dislocation (3,4).
- In most cases, imaging should be considered confirmatory, not solely diagnostic.

Treatment options

On-the-field/training room treatment:

- Attempted relocation using any of several recognized methods is a first-line treatment. Successful relocation is aided by an early attempt before the development of muscular spasm.
- Neurovascular assessment is essential before any attempt at relocation and after successful relocation.
- If the decision to not reduce is made on field, or on-field attempts at reduction are unsuccessful, immobilize the shoulder with immediate referral to the emergency department.
- Once reduced, immobilize the shoulder, implement pain management (5), and plan for follow-up.
- Same-day RTP may be considered in some circumstances in athletes with recurrent dislocations (e.g., easy relocation, little-to-no pain, full ROM, and protective strength).
- Postreduction radiographs should always be obtained after first-time dislocation.

Office treatment:

- Office treatment will depend on the dislocation characteristics (e.g., acute vs chronic, traumatic vs atraumatic, dislocation vs subluxation, first-time vs recurrent) as well as age, sex, activity level, and timeline for future sports activity.
- Sling for comfort/pain control with the intention of progressing to physical therapy. Current evidence does not support a specific duration of sling use.

- The use of acetaminophen and low-dose, short-term nonsteroidal anti-inflammatory drugs, which do not have a detrimental effect on healing (6–8), as needed for pain control. Opioids should be used sparingly if at all (5).
- Physical therapy includes joint ROM, restoring scapular control, rotator cuff strength, and sport-specific conditioning.
- Athletes with recurrent dislocations may or may not include immobilization and may have an accelerated treatment program.
- Bracing can be considered in the athlete's initial treatment depending on the timeline for future sports activity.

Operative treatment options

- Operative treatment will depend on the dislocation characteristics (e.g., acute vs chronic, traumatic vs atraumatic, dislocation vs subluxation, first-time vs recurrent) as well as age, activity level, and timeline for future sports activity.
- Surgery after a first-time traumatic anterior or posterior dislocation can often reduce the risk of a subsequent dislocation and improve outcomes (9).
- The arthroscopic or open Bankart Repair is the most commonly used procedure for soft tissue repair after a first-time AP dislocation.
- In athletes with certain presentations (e.g., recurrent dislocations, chronically dislocated shoulder, significant glenoid bone loss), other procedures may be necessary.

It is essential the team physician

- Identify and accurately diagnose shoulder dislocations.
- Assess for concomitant injury.
- Understand that radiographs should be obtained after the relocation of a first-time dislocation.
- Establish a protocol of on-field/training room relocation and/or referral to the ED as part of the emergency action plan.
- Identify criteria for referral.

It is desirable the team physician

- Be familiar with and perform recognized relocation methods for shoulder dislocations.
- Understand and implement indications for nonoperative and operative treatment.
- Identify known dislocation and subluxation risk factors as a basis for assessment and management.
- Understand indications and interpretation of advanced imaging.
- Educate the athletic care network on shoulder instability as it relates to the athlete's sport and establish a program to decrease risk of recurrent dislocation with early medical intervention.

The Disabled Throwing Shoulder (DTS)

The overhead throwing shoulder motion is a complex activity with contributions through the entire kinetic chain (10). Problems may present as both a decline in performance and an injury. The anatomic injury in the shoulder may include labral, rotator cuff and biceps injury, as well as internal or external impingement or glenohumeral joint instability (11). The clinical signs and symptoms associated with the injured throwing shoulder have been found in association with kinetic chain deficits, including local and distant anatomic injury, alterations in muscle function, and alterations in the mechanics of the motion.

Mechanism of injury

Multiple deficits of the kinetic chain contribute to the mechanism of injury and include the following:

- Hip and core deficits include hip muscle weakness, shortened stride length, and trunk rotation tightness and weakness.
- Abnormal scapular motion (scapular dyskinesis), including scapular protraction and loss of inferior medial border control.
- Glenohumeral joint internal impingement created by scapular protraction and posterior humeral translation.
- Rotator cuff injury.
- Rotator cuff eccentric and endurance muscle weakness.
- Glenohumeral joint motion deficits in shoulder internal and external rotation.
- Biceps muscle tightness.
- Previous shoulder or kinetic chain injury.
- Early sports specialization.
- Excessive external load (e.g., playing in pain, multiple teams, pitch loads, or changes in workload (12).

Clinical presentation

An athlete with a disabled throwing shoulder may present with a decline in performance and/or pain after an acute event or chronic overload. Concomitant signs and symptoms may include upper extremity weakness, numbness, and skin color or temperature changes (due to vascular compromise, including thrombosis).

Office evaluation

Assessing an athlete with a disabled throwing shoulder includes questions regarding the following:

- Decline in performance (e.g., loss of pitch location or velocity)
- Pain location and timing (e.g., during throw, during game, acute/chronic), localized or generalized and/or specific positions of the throwing motion
- Joint symptoms (click, catch, pop, "tightness," "slide")
- Upper extremity or general body fatigue
- Change in load factors (intensity, frequency, conditioning, innings pitched, pitches thrown; pitch counts may underestimate true throwing volumes, as warm-up and cooldown throwing numbers are not routinely collected)

- Other upper extremity signs and symptoms
- Previous kinetic chain injuries
- Maneuvers the athlete has tried to decrease symptoms

Office examination

- Localizing symptoms with palpation and during upper extremity motion
- Active/passive shoulder ROM (i.e., IR, ER with scapula stabilized) with comparison to contralateral shoulder
- Muscle strength (e.g., rotator cuff, biceps with scapula stabilized)
- Muscle flexibility (e.g., biceps, pectoralis minor, latissimus dorsi)
- Provocative testing using one or a battery of recognized methods (13) (e.g., labral tests [O'Brien's, M-DLS, jerk], instability, and impingement)
- Scapula for static position and dynamic motion to assess for dyskinesis. Upper extremity evaluation (e.g., neurovascular status, elbow ROM, forearm flexibility)
- Kinetic chain screen (e.g., single-leg stability [stance, squat], hip ROM, trunk rotation, stride length)

Imaging

- Radiographs should routinely be obtained as part of the assessment. Views often obtained include AP internal rotation, AP external rotation, axillary, and Y views.
- The use of MRI or MRI arthrogram should be dictated by clinical presentation, physical examination, and radiographic findings.
- The use of other advanced imaging (e.g., ultrasound, CT, Doppler) should be dictated by clinical presentation, physical examination, and radiographic findings.
- In most cases, imaging should be considered confirmatory, not solely diagnostic.

Nonoperative treatment

Nonoperative management is the preferred course of initial treatment in most cases of DTS. Specific indications, rehabilitation goals, and timelines should be identified.

- Manage workload (e.g., no/reduced throwing or pitching, modify training and conditioning, no participation on multiple teams).
- Physical therapy to address musculoskeletal deficits and achieve specific goals (e.g., ROM, strength, scapula, kinetic chain).
- Plan for reassessment (usually after 3 to 6 wk of treatment) to determine initial improvements.
- The use of acetaminophen and low-dose, short-term nonsteroidal anti-inflammatory drugs, which do not have a detrimental effect on healing (6–8), as needed for pain control (5).
- Injection therapies as an adjunct to treatment and dictated by the clinical presentation and physical examination.

Operative treatment

- Surgery may be indicated in the failure of comprehensive nonoperative management and in the presence of specific clinical examination findings and confirmatory imaging.
- The surgical procedure should address all shoulder pathology (e.g., superior, posterior, anterior labral, rotator cuff, biceps) and be followed by a comprehensive postoperative rehabilitation program (14).

Injury risk modification

Interventions to modify injury risk include:

- Workload management (e.g., fatigue, pitch counts, recovery from pitch exposure, training, and conditioning) (12)
- Establishing comprehensive pitching mechanics programs
- Kinetic chain conditioning to address the identified musculoskeletal deficits associated with injury and injury risk (e.g., GH ROM, IR, ER, pronation, biceps flexibility, posterior shoulder eccentric strength, rotator cuff strength, scapular retraction control, hip strength, ROM, trunk rotation, and strength). In-season screening of the kinetic chain can assist in early recognition and injury prevention.
- Advise caution if weighted ball programs and pitching programs based on increasing velocity are used, as both have been associated with increased risk of injury (14).

It is essential the team physician understand

- DTS may present as a decline in performance or as an injury.
- DTS is complex with multiple causative factors that need to be addressed (e.g., kinetic chain, workload).
- Nonoperative management is the preferred course of initial treatment in most cases of DTS.

It is desirable the team physician

- Conduct a comprehensive physical exam of the kinetic chain and shoulder.
- Understand the indications and interpretation of imaging.
- Manage workload and address entire kinetic chain deficits as treatment strategies.
- Recognize the clinical indications for surgical treatment.
- Work with the athletic care network to develop, implement, and supervise a comprehensive nonoperative treatment program.

Elbow Ulnar Collateral Ligament Tear

The elbow ulnar collateral ligament (UCL) is the most important stabilizer versus valgus stress. UCL tears are very common in overhead and throwing athletes, and the incidence is increasing among young athletes. UCL tears occur commonly

in sports with repeated overhead activities, such as baseball, javelin, and tennis. Tears may occur as a result of a single traumatic event or an overload failure due to supraphysiologic loads. Presentation may be acute or chronic.

Mechanism of injury

- Acute traumatic injuries often result from falls on an outstretched arm, leading to acute valgus loading failure of the UCL or complete elbow dislocation.
- Acute-on-chronic injuries may occur when an athlete continues to compete despite a prodrome of pain that would indicate preexisting pathology or weakening of the ligament leading to a pop and complete rupture of the ligament.
- In UCL tears in overhead and throwing athletes, multiple deficits of the kinetic chain have been found as associated factors that may contribute to the mechanism of injury.
  - Hip and core deficits include hip muscle weakness, shortened stride length, and trunk rotation tightness and weakness
  - Scapular dyskinesis, including scapular protraction and loss of inferior medial border control
  - Rotator cuff injury
  - Rotator cuff eccentric and endurance muscle weakness
  - Glenohumeral joint motion deficits in shoulder internal and external rotation
  - Biceps muscle tightness/increased elbow flexion
  - Sidearm throwing motion
  - Previous shoulder or kinetic chain injury
  - Early sports specialization
  - Excessive external load (e.g., playing in pain, multiple teams, pitch loads, change in workload) (12)

Clinical presentation

- The most common symptom is pain over the medial aspect of the elbow just distal to the epicondyle made worse during throwing and overhead activities. Associated symptoms may include paresthesia or locking.
- The onset of pain may be gradual or associated with a single event correlated with a popping or tearing sensation.
- Athletes may present with a decline in performance affecting power, speed, accuracy, or endurance.

Evaluation

Assessing an athlete with an UCL tear involves obtaining a comprehensive history, including

- Acute or chronic onset; traumatic or nontraumatic; presence or absence of prodromal pain
- Pain location and timing (e.g., during throw, during game, acute/chronic), localized or generalized and/or specific positions of the throwing or overhead motion
- Decline in performance affecting power, speed, accuracy, or endurance
- Specific questions about technique and volume of load are extremely important. For a baseball/softball pitcher, changes in technique, innings pitched, and concomitant lower extremity injuries can contribute to elbow pain
- Specific questions about previous kinetic chain injuries
- Neurovascular symptoms

Examination

- Focused palpation can clarify if the medial elbow pain is located at the medial epicondyle, within the proximal aspect of the flexor tendon insertion onto the medial epicondyle, the collateral ligament, or its insertion onto the sublime tubercle of the ulna.
- Assess for elbow ROM and compare to the contralateral side
- Resisted forearm flexion can clarify any involvement of the flexor or pronator muscles.
- Valgus loading should be performed with the elbow in slight flexion and extension. Dynamic valgus testing (e.g., milking maneuver and the Mayo moving valgus stress test) is more reliable in assessing UCL tear (15).
- A stepwise assessment of the ulnar nerve at the cubital tunnel should always be performed, including a Tinel's for local neuritis, inspection with flexion and extension to evaluate for ulnar nerve subluxation, and distal neurovascular examination for intrinsic hand function and sensation of the ulnar two fingers.

Imaging

- Radiographs are routinely performed. Comparison views should be performed in the skeletally immature athlete to assess for avulsion injury. Dynamic stress views are used less commonly in favor of MRI scans.
- MRI/MRI arthrogram provides the best combination of sensitivity and specificity when evaluating UCL tears.
- Dynamic ultrasound is an increasingly used modality (16,17).

Nonoperative treatment

- Nonoperative treatment is the initial management strategy for most UCL tears. The prognosis is more favorable in nonthrowing athletes than overhead throwing athletes.
- Initial treatment of an acute injury begins with joint protection and pain control, the length of which depends on the severity of the tear. Early protected ROM is strongly encouraged for most medial elbow injuries to avoid residual stiffness.
- The use of acetaminophen and low-dose, short-term nonsteroidal anti-inflammatory drugs, which do not have a detrimental effect on healing (6–8), as needed for pain control. Opioids should be used sparingly if at all (5).

- Physical therapy to address motion and strength across the elbow and rehabilitation of each link of the kinetic chain.
- The final stages of rehabilitation should include a gradual progress of sport-specific skills and training intensity. For throwers, this should include a specific RTP throwing protocol.
- Corticosteroid injections should not be used in this region due to risk of weakening the ligament.
- Currently, there is a lack of high-quality evidence for the use of biologic/regenerative therapy.

Operative treatment

- Operative treatment is reserved for high-demand overhead athletes and those who have failed nonoperative treatment.
- The UCL reconstruction (often referred to as the "Tommy John" procedure) is the preferred operative treatment. In select youth athletes, primary repair may be considered, with the understanding that the reconstruction or repair is indicated only for proven UCL tears and not as performance enhancement.
- UCL reconstruction is generally successful, but athletes require extensive postoperative recovery and rehabilitation. Most athletes are out of their overhead sport for 12 months or longer, and there is a risk of not returning to their previous level of activity.

Injury risk modification

Interventions to modify injury risk include:

- Workload management (e.g., fatigue, pitch counts, recovery from pitch exposure, monitor acute/chronic workload ratio, training, and conditioning) (12)
- Establishing comprehensive pitching mechanics programs
- Kinetic chain conditioning to address the identified musculoskeletal deficits associated with injury and injury risk (e.g., GH ROM, IR, ER, pronation, biceps flexibility, posterior shoulder eccentric strength, rotator cuff strength, scapular retraction control, hip strength, ROM, trunk rotation, and strength). In-season screening of the kinetic chain can assist in early recognition and injury prevention.
- Advise caution if weighted ball programs and pitching programs based on increasing velocity are used, as both have been associated with increased risk of injury (14).

It is essential the team physician

- Identify and diagnose a UCL injury
- Recognize not all athletes with UCL injuries require surgery. Some throwing athletes may require operative treatment to return to a high level of function.
- Understand the importance of monitoring load and the role of the kinetic chain to reduce the risk of UCL injuries.

It is desirable the team physician

- Recognize sports that are at greatest risk of UCL injuries.
- Understand nonoperative treatment is the initial management strategy for most UCL tears. The prognosis is more favorable in nonthrowing athletes than overhead throwing athletes.
- Understand the importance of reducing the incidence of UCL injuries, particularly in the skeletally immature population.
- Understand and use dynamic UCL stress testing (milking maneuver and Mayo moving valgus stress test) to aid in the diagnosis of a tear.
- Understand the indications and interpretation of imaging).
- Recognize which athletes would benefit from surgical intervention and when to refer.
- Understand the prognosis of surgical intervention and recovery timeline.
- Work with the athletic care network to evaluate throwing mechanics and injury risk modifications.

Hamstring Injury

Hamstring injury is the most common noncontact muscle injury in several sports, including soccer, American tackle football, Australian-rules football, rugby, track and field, basketball, and other Olympic sports (18–23). This injury occurs more frequently in competition versus training, may be associated with significant time loss, and has a high rate of recurrence (18–20). In professional football/soccer, the reported rate of injury is increasing during training (19). There are a variety of grading systems for hamstring injury, which incorporate a combination of signs, symptoms, and imaging. There is not a universally preferred system (24–26).

Mechanism of injury

The most common mechanism is eccentric muscle strain during the late swing phase of the running gait cycle ("high-speed running") (27,28). The most common hamstring muscle affected is the biceps femoris, more likely proximal versus distal and at the muscle tendon junction. A less common mechanism is a "stretch" injury, which occurs during movements where the hamstring is lengthened with simultaneous hip flexion and knee extension (e.g., high kicking, slide tackle or sagittal splits in soccer, dancing maneuvers, water skiing). The proximal semimembranosus tendon is the most commonly affected with this stretch mechanism. The most common known risk factors are previous hamstring injury and age (23,29–31). Other possible risk factors include fatigue, load/overload, quadricep/hamstring ratio imbalance, core weakness, and diminished hamstring eccentric strength (22,23,29,30,32).

Clinical presentation

- Acute onset of localized, significant posterior thigh or buttock pain often affecting ability to play.

- The athlete may report an audible or perceived pop or pulling/tearing sensation.
- Paresthesia and weakness may also be reported.

Evaluation

Assessing an athlete with a hamstring muscle injury involves obtaining a comprehensive history, including:

- Mechanism of injury
- Ability to continue participation
- Presence of limp
- Presence of bruising
- Pain with sitting (especially on hard surfaces)
- Pain and weakness with knee flexion
- Previous history of hamstring injury
- Timing, onset, and amount of swelling
- Presence of paresthesia and weakness

Examination

- Inspection for ecchymosis or obvious deformity
- Palpation for tenderness along the course of the posterior thigh, with measurement of the length of the tenderness
- Palpation for defect particularly at the ischial tuberosity
- Pain with passive stretch or pain or weakness with resisted knee flexion at varying degrees
- The popliteal angle should be measured bilaterally and compared with the uninjured leg to understand hamstring flexibility.
- Neurovascular examination
- Evidence-based clinical exam findings that can aid in determining prognosis, RTP, and recurrence include antalgic gait pattern, tenderness to palpation, active knee extension deficit, greater popliteal angle, and ability to perform a single-leg bridge with affected leg extended without pain (33–35).

Imaging

- Radiographs should be performed if suspect bony avulsion or apophyseal injury.
- MRI is the most commonly used tool to show location and severity of the injury.
- MRI findings for predicting prognosis are controversial (35–45).
- There is no evidence that MRI findings will predict recurrent injury (35).
- Although dynamic ultrasound use is increasingly common, efficacy is inconclusive for diagnosis and predicting recurrent injury (46).

Nonoperative treatment

- Most hamstring muscle injuries are treated nonoperatively.
- Initial treatment is individualized and involves progression based on pain, gait, severity of injury, and level of function (35,47).
- Restore pain-free ROM and normalization of gait using compression.
- Avoid massage in the first 24–48 h after injury and early isometric exercise.
- The use of acetaminophen and low-dose, short-term nonsteroidal anti-inflammatory drugs, which do not have a detrimental effect on healing (6–8).
- There is no high-quality clinical evidence to support the use of corticosteroid and PRP or other biologic injection and/or aspiration in initial treatment (48–50).
- Initiate eccentric strengthening when clinically indicated.
- Low-intensity exercise (e.g., stationary bicycle, exercise in pool) may be permitted.
- After initial symptoms have decreased, a comprehensive rehabilitation program, including ROM, stretching, continued eccentric strengthening, neuromuscular training, and sport-specific exercises, is indicated.

Operative treatment

- Indications for operative treatment for proximal hamstring injuries include those involving two tendons with >2 cm of retraction and three-tendon tears or avulsions that are displaced greater than 2 cm, best managed within 4 wk (50).

Injury risk modification

- Increasing body of evidence demonstrating reduced risk of sustaining hamstring injury with eccentric strength training (51–53).
- Core stabilizing exercises have been shown to decrease load and reduce risk of injury (54).
- Multimodal programs (e.g., FIFA 11) have been shown to reduce injury risk (54).
- Monitoring load/overload and fatigue emphasizing rest and recovery (12).
- There is no high-quality clinical evidence on the value of stretching as a risk modification strategy.

It is essential that the team physician understand

- How to identify and diagnose hamstring injuries.
- Most hamstring injuries are treated nonoperatively.
- Avulsion injury requires prompt referral.
- Hamstring injury is common in several sports and can be associated with significant time loss, especially if recurrent.

It is desirable that the team physician

- Obtain a thorough history and perform comprehensive physical examination.

- Understand clinical exam findings can aid in determining prognosis and RTP.
- Understand the indications and interpretation of imaging.
- Understand prevention programs that are multimodal (e.g., concentric strengthening, proprioception, neuromuscular control) and include eccentric loading can significantly decrease the incidence and severity of injury.
- Understand injury may be reduced by modifying risk factors.
- Understand indications for surgical intervention.
- Work with the athletic care network on the management and RTP progression for athletes with hamstring injury.

ACL TEAR

ACL tears are common in athletes and categorized as contact or noncontact and may be isolated or in combination with other knee joint injuries. The most common mechanism is a noncontact injury during acceleration/deceleration, pivoting, cutting, and jumping or landing from a jump with the knee slightly flexed and in a valgus position. In sports with same rules (e.g., basketball, soccer), noncontact ACL tears are more common in female athletes (54,55).

Mechanism of injury

ACL tears have two basic mechanisms of injury. The contact injury involves a forceful direct blow to the planted leg; noncontact more commonly involves sudden deceleration rotation injury. Contact ACL injury more often involves multiple ligaments. Noncontact ACL tears more often involve isolated ligament injury. Risk factors that contribute to noncontact injury mechanisms are multifactorial and include female sex, loss of neuromuscular control, lower extremity alignment, and local skeletal anatomy (notch width, tibial slope).

Clinical presentation

Noncontact and contact ACL tears present as an acute injury, often with an audible or perceived "pop" and the knee "giving out." It commonly includes onset of immediate pain and swelling with difficulty bearing weight.

Evaluation

Assessing an athlete with an ACL tear involves obtaining a comprehensive history, including

- Mechanism of injury
- Knee instability (e.g., knee buckling, shifting, giving way)
- Ability to continue participation
- Swelling: timing, onset, and amount
- Pain: timing, location, and severity
- History of previous ACL injury of either knee or previous lower extremity injury

Examination

- Inspection for effusion with associated loss of ROM and difficulty bearing weight.
- The Lachman test is the most sensitive clinical diagnostic test (56). It is important to compare the detected laxity to the uninjured knee. Both the degree of anterior tibial excursion and the quality of "end point" are valuable in making an accurate diagnosis.
- Comprehensive examination to evaluate for intra-articular and/or ligamentous injury (e.g., meniscal, posterolateral corner injury, collateral ligaments, PCL), acute patellar instability.
- Comprehensive examination also includes assessment of neurovascular status.

Imaging

- Radiographs of the knee, including AP, lateral, notch, and sunrise views, are routinely obtained. A Segond fracture (a small avulsion fracture off the lateral tibial plateau) is frequently associated with an acute ACL tear.
- MRI is highly accurate for confirming ACL tear, as well as other intra-articular and/or ligamentous injury.

Nonoperative treatment

- Proper counseling of the athlete about the risks and benefits of operative versus nonoperative management is critical. The shared decision on surgical intervention should be individualized.
- Age, activity level, timeline for future sports activity, level of sports, the existence of coexisting meniscal, chondral, or ligamentous damage, and their willingness to comply with a structured rehabilitation program should be factors in determining management.
- The use of acetaminophen and low-dose, short-term nonsteroidal anti-inflammatory drugs, which do not have a detrimental effect on healing (6–8). Opioids should be used sparingly if at all (5).
- Nonoperative treatment is associated with risk of meniscal and chondral injury (57,58).

ACL injury alone is associated with future risk of osteoarthritis with or without surgical intervention.

- Nonoperative protocols are designed to prevent further knee joint damage by restoring ROM, strength, endurance, and neuromuscular control.
- Nonoperative treatment protocols with structured, progressive rehabilitation are options for athletes who seek to return to only straight-ahead activities (59,60) (e.g., jogging, cycling, swimming) or sports that do not require pivoting, cutting, or landing from jumping.
- A small subset of athletes (termed "copers") may regain functional knee stability after progressive rehabilitation, including return preinjury sports activity level including jumping, cutting, pivoting, and/or lateral movements without an ACL reconstruction (61,62).
- Bracing alone to prevent future subluxation is ineffective.

Operative treatment

- Indications for surgery include gross symptomatic instability, desire to play a sport involving jumping, cutting and pivoting, failure of nonoperative management and prevention of future intra-articular injuries (2,59,60,63–65).
- ACL reconstruction is the most common procedure. Both allograft and autograft tissue may be used in the reconstruction with proper understanding of the benefits and cautions of each graft source.
- Intra-articular and/or other ligamentous injuries may occur with ACL injury. Multiligamentous knee injuries and/or displaced bucket handle meniscal tear may warrant prompt surgical referral.
- ACL reconstruction is routinely performed after resolution of hemarthrosis, improvement of ROM, and neuromuscular control and often requires prehabilitation (59).
- In young athletes, the surgical approach is determined by skeletal maturity.

Risk modification

- Primary prevention programs have been shown to decrease the incidence of ACL injuries (66). These programs should be recommended for athletes who participate in high-risk sports.
- Postoperative completion of a rehabilitation program before return to high-level sports is important in preventing reinjury. Return to high-risk sports before the athlete is physically and psychologically ready should be avoided (67).

It is essential the team physician understand

- ACL tears can result from contact or noncontact mechanisms and there are multiple risk factors for noncontact ACL tears.
- Common clinical presentations of ACL injury.
- How to identify and diagnose ACL injury and multiple ligamentous injury.
- Operative and nonoperative treatments are options after ACL injury. A shared decision-making process should be individualized.
- Indications for surgical referral.

It is desirable the team physician

- Perform a comprehensive knee joint examination assessing for all intra-articular, ligamentous injuries, and acute patellar instability.
- Understand and implement primary prevention strategies and postoperative rehabilitation.
- Understand the indications and interpretation of imaging.
- Understand that the ACL injury itself is a separate risk factor for future risk of osteoarthritis independent of the type of treatment (operative or nonoperative).
- Work with the athletic care network to develop an injury management and RTP strategy.

Meniscus Tear

Meniscus tears are common in athletes and are categorized as traumatic or degenerative. Traumatic tears are most often observed in young athletes and present as a tear to an otherwise healthy meniscus. Degenerative meniscus tears are more common in older athletes.

Meniscus tears are more frequent in men than women. The medial meniscus is more commonly injured than the lateral meniscus. Meniscus tears are often associated with ACL injuries.

Mechanism of injury

- Isolated, acute injuries to the meniscus result from twisting, cutting, or pivoting on a planted foot creating compressive and shear forces through the meniscus. They are more common in dynamic sports requiring quick changes in direction but may also be seen in sports like golf, where athletes rotate on a planted leg as part of the swing motion.
- In jumping activities and sports such as basketball and volleyball, the additional element of a vertical force with angular momentum on landing can contribute to a meniscal injury.
- Deep knee flexion associated with even small amounts of rotation may result in injuries to the meniscus.
- Ligament injuries, in which increased tibial translation occurs, can displace the menisci from its peripheral attachments and result in a tear.

Clinical presentation

- A history of a twisting injury with or without a "pop" is commonly described.
- Focal medial or lateral joint line pain, swelling, pain with full flexion/extension, and/or mechanical catching preventing full and fluid ROM are common complaints.

Evaluation

Assessing an athlete with meniscal tear includes a comprehensive history, including:

- Acute or chronic onset; traumatic or nontraumatic
- Localization of medial or lateral joint line pain
- The report of a "pop" or other mechanical symptoms (e.g., locking, restricted ROM)
- Joint swelling after injury

Examination

- A knee effusion may be present. It generally does not develop immediately and is smaller than the effusion present after an injury to the ACL.

- On palpation, the athlete may experience focal tenderness over the medial or lateral joint line, typically in posteromedial or posterolateral locations.
- ROM may be normal, but terminal flexion and extension are commonly painful. A lack of full extension may indicate a displaced meniscus tear causing mechanical block.
- Quadriceps inhibition may be noted on strength testing in the presence of a joint effusion.
- Special testing using one or a battery of recognized methods (e.g., Thessaly, McMurray, Apley's, Bounce Home) should provoke symptoms related to meniscus pathology but can be relatively nonspecific.

Imaging

- Radiographs of the knee at a minimum include AP and lateral views.
- MRI is a useful tool with a high accuracy for discriminating meniscus tears and other pathologies and should be determined by the clinical presentation and physical examination.

Non operative treatment

- Not every athlete with a confirmed meniscal tear will require surgery. Risks of not performing surgery (e.g., propagation of tear, osteoarthritis) should be discussed with the injured athlete.
- Low-dose, short-term nonsteroidal anti-inflammatory drugs, which do not have a detrimental effect on healing (6–8), or acetaminophen, relative rest, avoiding activities that provoke pain (especially deep knee flexion), and serial clinical evaluations, are recommended. Opioids are rarely indicated (5).
- Physical therapy, including ROM and strengthening, may be indicated.

Operative treatment

- Locked knee warrants prompt surgical referral.
- Arthroscopic intervention is recommended for athletes with bucket handle tears, other displaced meniscal tears or meniscus pathology that have not responded to nonoperative management.
- The primary goal of arthroscopic intervention is to restore normal knee function while preserving as much functional meniscus as possible. Smaller meniscus tears not responding to simple conservative measures benefit from simple debridement. For larger complex meniscus tears, meniscal repair should be considered. In general, meniscal tears that are repaired acutely achieve superior results compared with tears repaired later in the clinical course.
- Recovery from simple debridement compared with meniscal repair is substantially different. Athletes considering debridement versus repair should be carefully counseled about benefits and pitfalls of each.
- Meniscal repair has a higher success rate when performed in conjunction with ACL reconstruction. Meniscal healing rates are typically lower in an ACL-deficient knee, and repair may be contraindicated if the ACL is not also reconstructed.

It is essential the team physician understand

- Common meniscal injury mechanisms and typical clinical presentation
- Clinical indications for nonoperative and surgical care
- Locked knee warrants prompt surgical referral
- How to identify and diagnose meniscal tear
- The role of imaging in the diagnosis and management of a meniscus tear

It is desirable the team physician

- Perform a comprehensive knee joint examination.
- Understand the extent of meniscus pathology and clinical presentation to counsel athletes about timing of advanced imaging and surgical referral/intervention.
- Understand the indications and interpretation of imaging.
- Understand that meniscal tears that are repaired acutely achieve superior results compared with tears repaired later in the clinical course.
- Work with the athletic care network to optimize care of the injured athlete.

Ankle | Sprain

Acute ankle sprains are the most common lower limb injury in athletes with lateral ankle sprains being most frequent. They can be associated with other lower extremity injuries.

Mechanism of injury

There are two primary mechanisms of acute ankle sprain: inversion/plantar flexion involving the lateral ligament complex and eversion/dorsiflexion involving the medial ligament complex. High ankle sprains involve the syndesmotic structures with the most common mechanism of injury involves eversion/dorsiflexion with an external rotational component.

Risk factors for acute ankle sprain include the following (68,69):

- Sport with running, landing, cutting (e.g., basketball, volleyball, rugby, American football, soccer)
- Previous ankle injury (ligamentous instability, incomplete rehabilitation, decreased ankle dorsiflexion ROM, and/or poor proprioception)
- Female sex
- Peroneal (fibular) muscle weakness in injured and noninjured ankles

- Hindfoot alignment (e.g., heel varus and cavovarus) and tarsal coalition
- Increased body mass index
- Playing surfaces

Clinical presentation

- Common clinical presentation includes pain, swelling, and difficulty bearing weight after a rolling and/or twisting injury.

Evaluation

Assessing an athlete with an ankle sprain involves obtaining a comprehensive history, including:

- Mechanism of injury
- Ability to bear weight and/or continue participation (inability to bear weight should cause consideration for more significant injury such as fracture)
- Time of onset, location, and severity of pain and swelling
- Previous ankle injury and specifics of rehabilitation

Examination

- Associated injuries may include fibular or fifth metatarsal fractures, peroneal tendon subluxation, and talar dome injuries
- Inspection for swelling and/or ecchymosis and alignment of the foot and ankle
- Normal weight bearing and/or antalgic gait
- Testing for ROM of the ankle and subtalar joint
- Tenderness with palpation over bony landmarks (e.g., entire fibula, medial malleoli, and base of fifth metatarsal)
- Tenderness with palpation over medial and lateral ligament complex and ankle syndesmosis
- Ligament exam: anterior drawer, talar tilt, passive external rotation with the ankle in dorsiflexion
- Squeeze test for syndesmosis injury and instability
- Assess neurovascular status

Imaging

- Ottawa Ankle Rules, which have been validated in the acute ED setting, may be helpful in guiding decisions regarding imaging (68).
  - Bone tenderness in distal 6 cm of posterior half of tibia or tip of medial malleolus
  - Bone tenderness in distal 6 cm of posterior half of the fibula or tip or lateral malleolus
  - Inability to bear weight
- When radiographs are ordered, at a minimum AP, lateral and mortise views are indicated. Stress views may be considered.
- MRI may be considered when examination or radiographs reveal significant injury, persistent disability, or in cases of concern for concomitant injury.
- Ultrasound may be as precise as MRI for identifying partial or complete ankle ligament tears, but is highly operator dependent (70,71).

Nonoperative treatment

- Most acute ankle sprains are initially treated nonoperatively.
- Early management goals are to promote healing and protect from further injury. The application of rehabilitative principles to promote recovery and reduce risk for chronic pain and disability should be implemented immediately after initial evaluation.
- Initial treatment is compression and immobilization. Functional bracing and taping are preferred over rigid immobilization (68).
- Modified activity with early weight bearing as tolerated.
- Cryotherapy and other modalities (e.g., ultrasound, electrotherapy, and laser), although widely used, have questionable efficacy in the acute postinjury period.
- The use of acetaminophen and low-dose, short-term nonsteroidal anti-inflammatory drugs, which do not have a detrimental effect on healing (6–8), is common for pain control. Opioids are rarely indicated (5).
- There is no evidence to support the use of injectable biologic therapy (72).
- After initial symptoms have decreased, a comprehensive rehabilitation program, including ROM, stretching, strengthening, neuromuscular proprioceptive, and sport-specific exercises, is indicated.

Operative treatment

- Ankle injuries with gross instability or proximal fibula fracture require prompt referral.
- Indications in acute injuries may include concomitant injuries (e.g., fracture, osteochondral injury, peroneal subluxation, significant syndesmotic injury with instability).
- Indications in chronic injuries include failure of nonoperative treatment, recurrent ankle injuries due to joint instability, and concomitant pathology.
- The technique involves repair and/or reconstruction of the injured ligaments and tissues.

Risk modification

- Risk modification programs for athletes with a history of previous ankle injury should address ankle muscle strength and flexibility, neuromuscular proprioceptive training, and core muscle control and heel alignment.
- Ankle bracing and/or taping is effective for secondary prevention but may be less effective for primary prevention (68).

It is essential that the team physician understand

- Common ankle injury mechanisms and typical clinical presentation
- Indications for prompt surgical referral
- How to identify and diagnose the ankle sprain
- Concomitant injuries may be present
- When imaging is indicated

It is desirable the team physician

- Perform a comprehensive physical examination.
- Understand the role of bracing and taping.
- Understand the indications and interpretation of imaging.
- Understand the indications for surgical treatment.
- Develop and implement a comprehensive rehabilitation program to maximize recovery.
- Work with the athletic care network on the principles and practices of ankle injury prevention and treatment.

GROIN PAIN

Groin injuries are common but challenged by considerable controversy over basic terminology (e.g., core muscle injury, athletic pubalgia, Gilmore's groin, slap shot gut, sports hernia, and sportsman's hernia). Groin pain can be categorized into two major musculoskeletal etiologies, using frameworks provided by the Doha and Warwick agreements (73). The first is medial or inguinal groin pain resulting from extra-articular musculoskeletal structures (adductor-related, iliopsoas-related, inguinal-related) and pubis (pubic-related groin pain). The second is intra-articular hip-related groin pain in an athletic population as FAI. FAI syndrome is a motion-related clinical disorder of the hip with a triad of symptoms, clinical signs, and imaging findings. It represents symptomatic atypical contact between the proximal femur and the acetabulum. FAI is not an injury but the most common cause of intra-articular hip pain in professional and recreational athletes (74). Other etiologies of groin pain are outside the scope of this article.

Mechanism of medial non-FAI groin pain

The most common mechanism leading to the development of groin pain is a chronic increase in tension in the peripubic musculotendinous structures as a result of high levels of twisting, turning, running, or kicking. Less commonly, injury onset can be acute in the setting of abdominal hyperextension and hip abduction (like kicking), resulting in tearing of the rectus abdominus/adductor aponeurosis. Given this, groin pain is quite common in sports such as American tackle football, ice hockey, and football/soccer where rapid pivoting and cutting are common.

There is a complex role of the bony anatomy of FAI in the development of medial non-FAI groin pain (75–78). FAI will commonly restrict hip ROM in multiple planes. This impingement has been shown to result in increased rotational motion at the pubic symphysis, possibly placing patients with FAI at increased risk for injury to medial extra-articular musculoskeletal structures and pubis (79,80).

Clinical presentation: medial non-FAI groin pain

- Groin, anterior hip, and lower abdominal pain that may radiate to the rectus abdominus and the proximal adductor region.
- Activities that often exacerbate pain include acceleration/deceleration, cutting and pivoting, or kicking.
- Pain is typically relieved by rest (81–83). Although pain is most often reported unilaterally, some patients report pain bilaterally (84).
- With abdominal straining or coughing, pain may radiate to the groin, thigh or perineum (85).

Evaluation

Assessing an athlete with medial non-FAI groin pain involves obtaining a comprehensive history, including:

- Acute or chronic onset and exacerbating factors
- Location, severity, and exacerbating factors
- Hip joint pain and decreased ROM
- Inguinal-related paresthesia
- Ability to continue sports participation
- Consideration of other etiologies (e.g., lumbar spine, GI, GU)

Examination

- Palpation for point tenderness at the rectus insertion, inguinal fold, along the course of the iliopsoas, adductor origin, and pubic symphysis (81,82)
- Hip joint assessment to include pain, ROM, strength, and special tests to include flexion adduction internal rotation (FADIR) and flexion abduction external rotation (FABER)
- Provocative tests for pain and strength should be performed (resisted adduction, resisted seated hip flexion, resisted sit-up test, palpation of the rectus abdominis at its lateral edge at the pubis while doing sit-up)
- Core stability assessment: Trendelenburg testing, pelvic bridge
- Assess for inguinal or femoral hernia
- Neurovascular examination

Imaging

- Plain radiographs, including standing anteroposterior pelvis and lateral hip to assess for osteoarthritis, FAI, stress fracture, avulsion injury, or hip dysplasia, as well as osteitis pubis.
- MRI with specific protocols is the imaging study of choice to properly assess for medial non-FAI groin pain (85).
- Ultrasound may be valuable in the evaluation and management of medial non-FAI groin pain (86).

Nonoperative treatment

- Initial treatment is frequently managed without surgical intervention.

- Treatment should be individualized considering player sport, position, timing in season, degree of limitation, and previous nonoperative treatment.
- Activity modification and relative rest are essential in managing symptoms and pain.
- The use of acetaminophen and low-dose, short-term nonsteroidal anti-inflammatory drugs, which do not have a detrimental effect on healing (6–8), as needed for pain control.
- After initial symptoms have decreased, a comprehensive rehabilitation program focusing on enhancing both the flexibility and the strength of the core stabilizers, including hip flexors, abductors, and adductors.
- Injections have been used as a treatment option, but there is a lack of high-quality evidence on efficacy.

Operative treatment

- When comprehensive nonoperative treatment has been exhausted and athletes continue to experience pain and loss of function, operative management can be considered.
- A number of operative techniques exist, including open repair, "minimally invasive" repair, and laparoscopic options, with and without mesh, all of which report improvements in pain and return to sport (86–94).

Risk factor modifications

- Athletes who rely on rapid acceleration/deceleration, twisting, or kicking are at an increased risk for medial non-FAI groin pain and may be susceptible to injury and should undergo early screening.
- Optimize workload management, periodization, and recovery strategies.
- Neuromuscular training to optimize flexibility and muscle strength.
- A core stabilization program is considered an important intervention, although limited. evidence exists on efficacy (95,96). Consideration may also be given to improving hip joint ROM with joint mobilization and distraction techniques with limited evidence of efficacy.

HIP/GROIN: FAI

Mechanism of injury

- There are two main types of FAI—cam and pincer.
  - Cam FAI is characterized by loss of the normal contour between the femoral head and the neck.
  - Pincer FAI is due to acetabular overcoverage.
- Cam and pincer deformity may present in isolation, but mixed-type FAI, where both cam and pincer morphologies are present, is the most common form of FAI (97–102).
- There are many athletes who have the anatomy of FAI but no pain (103).
- Impingement may lead to tearing of the acetabular labrum and/or damage to the articular cartilage.
- Hip impingement classically occurs with hip internal rotation; however, the more hip flexion and/or adduction, the less internal rotation necessary to cause the abutment between the proximal femur and the acetabulum.

Clinical presentation

- Deep groin pain that is typically exacerbated by squatting, twisting, prolonged sitting, cutting and pivoting activities, and sudden stops and starts. It is usually alleviated with rest or refraining from activity.
- Athletes may demonstrate a "C" sign to localize their hip pain (104).
- FAI is often bilateral but presenting symptoms are often worse in one hip.

Evaluation

Assessing an athlete with FAI involves obtaining a comprehensive history, including:

- Acute or chronic onset and exacerbating factors
- Time of onset, location, and severity
- Previous injury
- Ability to continue sports participation

Examination

- Palpation of the periarticular structures to rule out other pathology. The hip joint with FAI is not tender to palpation.
- Observation of gait and seated posture.
- Patients typically have painful and reduced hip ROM, especially internal rotation.
- FADIR is performed by placing the hip in 90 degrees of flexion and adduction followed by forced internal rotation producing pain (105).
- The labral stress test or scour maneuver may be useful to identify labral pathology.
- Assess neurovascular status.

Imaging

- Radiographs should consist of standing AP pelvis and lateral hip at a minimum.
- Imaging may demonstrate the crossover sign, pistol grip deformity, or acetabular prominence, which are indicative of FAI (106).
- MRA is the confirmatory diagnostic tool preferred to examine for intra-articular pathology.
- Diagnostic injection with anesthetic may be useful to confirm the source of pain is intra-articular.

Nonoperative treatment

- Patients with FAI anatomy but absence of pain do not need treatment.
- Nonoperative treatment of FAI has been shown to be effective in improving symptoms in some patients and should be the first course of management.
- Treatment options include physical therapy, activity modification to avoid impingement (e.g., deep flexion, squatting, and heavy lower extremity weight lifting), and medication for pain control (primarily with low-dose, short-term nonsteroidal anti-inflammatory drugs, which do not have a detrimental effect on healing (6–8,97,98,102,107).
- PT should include core stabilization, reducing anterior pelvic tilt and mobilizing the hip (108).
- Image-guided intra-articular injection with a local anesthetic and corticosteroid may be therapeutic.
- Further research is necessary regarding the efficacy of injectable biologics/regenerative and viscosupplements (109).

Operative treatment

- After failed rehabilitation (either no improvement or incomplete improvement to return to desired activities), surgery may be indicated.
- FAI surgery is not indicated in the presence of significant osteoarthritis or significant dysplasia.
- Chondral lesions and labral tears are addressed simultaneously with correction of FAI pathology.

Risk modification

- Avoid exacerbating positions and motions (e.g., deep flexion, squatting, and heavy lower extremity weight lifting) as well as load management.

It is essential the team physician understand

- The presentation of various types of causes of groin pain.
- How to identify and diagnose different causes of groin pain.
- Initial treatment of medial non-FAI groin pain and FAI is nonoperative.
- FAI anatomy does not necessarily mean a patient needs treatment.

It is desirable the team physician understand

- Classification system (Doha and Warwick) and terminology associated with medial non-FAI groin pain and FAI.
- Medial non-FAI groin pain and FAI are common causes of groin pain, and FAI may be a contributing factor to the development of medial non-FAI groin pain.
- How to perform a comprehensive physical examination, including provocative tests for medial non-FAI groin pain and FAI.
- Indications and interpretation of imaging.
- The indications for surgical intervention.
- Realize specialized MRI sequences of the pelvis are necessary to confirm the presence of core muscle injury, although it is not 100% sensitive or specific.
- Educate the athletic care network about the signs and symptoms of groin pain.

HIP AND GROIN APOPHYSEAL INJURIES

Apophyseal injuries are separations and/or avulsions of the apophysis from the underlying bone and may occur at many locations on the hip and groin. These include the following (110,111):

- Anterior inferior iliac spine/rectus femoris muscle (33%–46%)
- Anterior superior iliac spine/sartorius muscle (28%–32%)
- Ischial tuberosity/hamstring muscles (12%–30%)
- Iliac crest/abdominal muscles (6.7%–11%)
- Lesser trochanter/Iliopsoas (1.8%)
- Symphysis pubis/adductor longus and brevis and gracilis muscles (1.2%)
- Greater trochanter/gluteus medius and minimus

Mechanism of injury

- Acute injuries are avulsions and occur due to concentric or eccentric loads along the muscle tendon unit.
- An acute avulsion may occur with a prodrome of pain due to preexistent apophysitis.
- Chronic injury is a partial injury occurring from repetitive loading leading to chronic irritation and overgrowth (i.e., apophysitis). Microfractures and inflammation within the apophyseal insertion lead to pain.
- The highest risk of injury is the time when the athlete is approaching skeletal maturity. At this time, there is a hormonal effect on muscle strength and a temporary decline in coordination and musculoskeletal balance as limb length increases at a faster rate during puberty than limb mass (112).
- Other risk factors include sports involving acceleration and deceleration (e.g., soccer, track and field, football, baseball, gymnastics), sudden forceful contraction, repetitive forceful actions, and direct trauma.

Clinical presentation

- In acute cases, the athlete will commonly report a specific event (e.g., kicking, sprinting, hurdling) where they felt a pop and then pain. There may be swelling and presence of a limp.
- In chronic cases, the athlete may present with gradual onset of pain during athletic activity.

Evaluation

Assessing an athlete with an apophyseal injury involves obtaining a comprehensive history, including:

- Acute or chronic onset and exacerbating factors
- Time of onset, location, and severity
- Previous apophysitis or muscle injury
- Increase in load (e.g., training intensity and volume) (12)
- Recent growth spurt

Examination

- Inspection for swelling and/or ecchymoses
- Palpation for tenderness and defect
- Resisted muscle testing and passive stretching to provoke pain
- Comprehensive extremity examination to evaluate for strength, flexibility, and kinetic chain deficits

Imaging

- AP and lateral pelvic radiographs are routinely obtained.
- Oblique radiographs may assist in providing tangential views of pathology not as easy to see on straight AP and laterals. Comparison views may be performed to look for subtle apophyseal irregularities or separation. Chronic cases may lead to excessive callous formation.
- MRI scans may visualize the tendon itself and provide a more definitive diagnosis for subtle separations or chronic apophysitis.
- CT scans provide better delineation of bone detail but usually are not necessary.
- Ultrasound and MRI may be useful in evaluating apophyseal injury in the hip and groin (113,114).
- In cases of a suspicious radiograph, MRI or ultrasound can be used to reveal a potential soft tissue injury (110).

Nonoperative treatment

- The majority of acute and chronic injuries are treated nonoperatively (110,115).
- Initial treatment includes pain control, relative rest, and modified activity.
- After initial symptoms have decreased, a comprehensive rehabilitation program, including ROM, stretching, strengthening, neuromuscular control, and sport-specific exercises, is indicated.
- Oral pharmacologic therapy is not a mainstay of treatment and there is no high-quality evidence for injection therapy.

Operative treatment

- Operative treatment may be considered for acute displaced avulsions.

Risk modification

- Workload management, periodization, and recovery strategies may be effective as the athlete is approaching skeletal maturity (116).
- Workload management for injury prevention may be accomplished by a gradual increase in training intensity and avoidance of any acute changes in load.
- Neuromuscular training to optimize flexibility and muscle strength during active phases of growth.

It is essential the team physician

- Recognize clinical presentation of various types of apophyseal injuries.
- How to conduct the history and physical examination.
- Injury mechanisms, clinical presentation, and recovery.

It is desirable the team physician understand

- The indications for surgical referral
- Indications and interpretation of imaging
- Sports at greatest risk of apophyseal injuries
- The importance of early recognition and treatment of apophysitis as a prodrome to reduce the risk of complete avulsions
- Educate the athletic care network about the signs and symptoms of hip and groin apophyseal injuries

Limitations

The Team Physician Consensus Statement published series is not intended as a standard of care and should not be interpreted as such. This document is only a guide, and as such, is of a general nature, consistent with the reasonable, objective practice of the healthcare professional. The focus populations for the statement are those individuals that a team physician would care for, typically the child to college or Olympic level aged athlete. Physician representatives from North America comprised the writing group. Given the broad nature of topics, only select topics are included. In addition, formal systematic review of the literature and level of evidence statements or strength of recommendation taxonomy are not included.

The opinions and assertions expressed herein are those of the author(s) and do not necessarily reflect the official policy or position of the Uniformed Services University or the Department of Defense or any of the individual institutions or leagues that authors are affiliated with.

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