Sideline Management of Joint Dislocations

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Abstract
Athletes can sustain a large variety of injuries from simple soft tissue sprains to complex fractures and joint dislocations. This article reviews and provides the most recent information for sports medicine professionals on the management of simple and complex joint dislocations, *i.e.*, irreducible and/or associated with a fracture, from the sidelines without the benefit of imaging. For each joint, the relevant anatomy, common mechanisms, sideline assessment, reduction techniques, initial treatment, and potential complications will be discussed, which allow for the safe and prompt return of athletes to the field of play.

Introduction

According to the U.S. Centers for Disease Control and Prevention's most recent available data, an estimated 2.6 million children (0 to 19) in the United States are annually treated in emergency rooms for sports and recreational-related injuries (64). Joint dislocations and separations represent 3.6% of all of these injuries (35). The three most commonly dislocated joints are shoulder (54.9%), wrist/hand (16.5%), and knee (16.0%) (35). The immediate recognition and treatment of joint dislocations can result in better outcomes for these injured athletes (63). The most challenging areas of sideline sports medicine are determining when injured athletes can safely return to play, especially without the aid of imaging. Using the available research and medical experience, this article will offer several approaches to evaluating and treating dislocations of joints in injured athletes on the sideline without worsening the dislocated joint or placing these athletes at greater risk for sustaining further injuries.

When evaluating any injured joint and possible dislocation, neurovascular status is the initial and most important step. This is performed by checking for distal sensation, motor function, capillary refill, and pulses in the affected extremity. If there is evidence of neurovascular compromise, then these immediate and appropriate steps should be followed. First, an on-the-field attempt to restore neurovascular status to the compromised extremity is reasonable and encouraged. Multiple attempts should not be performed unless emergency transport to the appropriate facility is unavailable for a substantial amount of time. Distal pulses should always be assessed before and after each manipulation. Keep in mind that joint dislocations have an increased risk for neurovascular compromise (28,29). Other indications for on-field joint reductions include the preservation of skin, pain reduction, and ease of splinting for transportation. Sports medicine providers should recall that fractures are the more commonly associated joint dislocations among the skeletally immature and older athletes (31). This is a crucial consideration before trying to reduce any joint dislocations prior to obtaining imaging because of the increased risk of displacing a fracture and/or turning a simple dislocation into a complex dislocation (28).

Most joint dislocations are nonemergent and can be managed on the sideline without the need for urgent transport and/or immediate imaging. After safely reducing a dislocated joint, the decision to determine whether injured athletes can safely return to play is the next important step. For the most part, there are no set return-to-play guidelines, and few articles for the sideline management of joint dislocations are available. Upon determining that the joint is back in anatomical position without an obvious deformity and the player desires to return to play, the player must pass a functional progression test that simulates a game environment. Essentially, the player must have full range of motion (ROM) of the injured joint with full strength and minimal discomfort (29).

Shoulder

Anatomy

The shoulder is the most mobile and most commonly dislocated joint in the body (16). Shoulders dislocate anteriorly approximately 95% of the time. Shoulders also dislocate posteriorly and inferiorly at rates of 5% and <1%, respectively (16). Anterior shoulder dislocations can be further classified based on where the humeral head is located on

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radiographs. They are most commonly subcoracoid, but also can be subglenoid, subclavicular, and rarely intrathoracic (60). The shoulder anatomy is very complex with both static and dynamic stabilizers, including the glenoid, glenoid labrum, glenohumeral capsular ligaments, rotator cuff, and scapular muscles. These and other structures help stabilize and prevent dislocation depending on the athlete's arm position and functional muscle control.

Mechanism

Anterior shoulder dislocations most commonly occur when the arm is forced into an abducted, externally rotated, and extended position (60). They also can occur from an anteriorly directed force on the posterior humerus driving the humeral head out of the glenohumeral joint anteriorly; however, this mechanism is much less common.

Posterior shoulder dislocations occur during a fall on an outstretched hand or elbow with the shoulder internally rotated. This drives the humeral head posteriorly out of the glenohumeral joint. Posterior dislocations also occur from high-velocity trauma, seizure activity, electroshock, and alcohol-related injury (25).

Inferior shoulder dislocations, or luxatio erecta, have two proposed mechanisms of injury. The first mechanism is forced hyperabduction to an abducted arm, which causes the acromion to act as a fulcrum levering the humeral head out of the glenohumeral joint inferiorly (3). The second mechanism is a direct blow to a fully abducted arm causing the humeral head to be driven inferiorly through the inferior glenohumeral ligaments and capsule (15).

Sideline Assessment

Athletes with anterior shoulder dislocations present with the arm in a slightly abducted and internally rotated position and may hold the injured wrist with their noninjured hand for support. The shoulder loses its normal rounded appearance. In most cases, the acromion may be obvious, especially in thin patients, with a flattened appearance inferiorly. The humeral head may be able to be palpated anteriorly or in the axilla. Asking the athlete to grab the opposite shoulder can be a quick way to determine whether the shoulder is dislocated anteriorly. If they are unable to do so, it is most likely dislocated; however, if they can, other possibilities should be explored.

Athletes with posterior dislocations present holding their arm internally rotated, adducted, and close to their body. The humeral head may be felt posteriorly. The anterior portion of the shoulder may have a flattened appearance (14).

Inferior dislocations, although rare, have a very common presentation that makes them almost unmistakable. The arm is hyperabducted and locked over the injured person's head with the elbow flexed; the forearm is pronated and is resting on top of the athlete's head (23).

Reduction Techniques

Many different shoulder reduction techniques have been described in the literature. No single technique has been proven to be superior to the others. Keep in mind that the athlete may not be able to sit in a chair or lay down, so having a working knowledge of several techniques is important. Prompt diagnosis and reduction of dislocations are critical in obtaining a successful reduction by limiting muscle spasm. This also limits compression to the neurovascular structures. Although we recommend a prompt reduction, every effort should be made to move the athlete off of the field of play to attempt a reduction maneuver. Ideally, these maneuvers should be done in the locker room away from coaches, teammates, or spectators to minimize distraction.

Anterior Shoulder Dislocation Reduction Techniques

Traction-countertraction method

The athlete is lying supine on a table or bed with a sheet or towel wrapped around the chest that is secured by an assistant pulling countertraction from the noninjured side of the patient. His elbow should be flexed to 90°. The provider is on the injured side using a sheet or towel that is tied connecting the provider's waist to the patient's proximal forearm. The provider grasps the patient's wrist and slowly pulls traction on the abducted arm while the assistant pulls countertraction (Fig. 1) (24).

Chair method

The athlete sits in a chair sideways with the dislocated shoulder hanging over the back of the chair. The provider sits or kneels on the backside of the chair grasping the patient's supinated wrist and providing traction. The athlete is encouraged to relax and slowly stand up. If reduction does not occur, flexing the elbow and externally rotating the shoulder may facilitate the reduction (Fig. 2) (38).

Spaso method

The athlete is placed in the supine position. The wrist or forearm is grasped and gentle traction is applied while the shoulder is forward flexed until the arm is perpendicular to the floor. At this point, the shoulder is slightly externally rotated. Reduction typically occurs after a few minutes with a noticeable clunk or click that is felt and sometimes heard (Fig. 3A–C) (21). One benefit of this method is that it can be done on the field if the athlete cannot be moved.

Milch method

The athlete is lying supine on a bed or table with the provider standing on the side of the dislocation. The provider grips the athlete's shoulder with the thumb braced firmly

Figure 1: Traction-countertraction method.

Figure 2: Chair method.

Figure 4: Milch method.

against the humeral head. The provider then slowly abducts the athlete's arm with their other hand. During this motion, the provider's hand and thumb are stabilizing the humeral head not to allow it to rotate downward. Once the arm is fully abducted, the provider applies slight traction allowing the provider's thumb to reduce the humeral head over the glenoid rim (Fig. 4) (57). There are many variations of this method described in the literature, including a seated version.

Stimson method

The athlete is placed in prone position with the dislocated arm hanging over the edge of the bed or table. Weights are attached to the hanging wrist providing downward traction, typically starting at 5 lb (2.27 kg) (Fig. 5) (71). The athlete is allowed to rest in this position until the reduction occurs. The disadvantage of this method is that it takes more than 15 to 20 min for reduction to take place. This technique has fallen out of favor for the newer, more efficient techniques.

Kocher method

The athlete is lying supine on a bed or table. The provider is on the same side as the dislocation. The arm is fully adducted to the side of the body and the elbow is flexed to 90°. The forearm is externally rotated until resistance is met. The athlete's arm is then flexed forward as much as possible. Finally, the arm is internally rotated until the reduction occurs (Fig. 6A–D) (17).

Fast, reliable, and safe method

The athlete is placed in the supine position on a bed or table with the torso and legs at the edge allowing the arm to freely hang off of the surface. The provider stands on the same side as the dislocation. The wrist is grasped in neutral position with the elbow fully extended. The provider pulls gentle traction on the wrist while simultaneously oscillating the arm approximately 5 cm above and below the neutral position of the arm at a rate of two to three oscillations per second and abducting the arm. When the arm gets to approximately 90° of abduction, slight external rotation is performed while continuing vertical oscillations and abduction. Reduction typically occurs around 120° of abduction (Fig. 7A and B) (56).

Posterior Shoulder Dislocation Reduction Technique

The athlete sits upright in a chair or is placed supine in a bed. An assistant pulls countertraction with a sheet or a towel around the athlete's torso while the provider performs the reduction on the injured side. The arm is flexed to 90° and adducted with internal rotation to disengage the humeral head from the rim of the glenoid. Traction is then applied longitudinally. When the humeral head disengages, gentle anterior force can be applied with external rotation for the reduction to occur (53,56). It should be noted that, if you suspect this type of dislocation, sedation may be necessary for a successful reduction.

Inferior Shoulder Dislocation Reduction Technique

The athlete is placed in a chair or sitting upright in a bed. The provider will pull traction to the abducted arm in a superior and lateral direction while an assistant provides countertraction with a sheet or towel around the torso of the athlete. Sufficient muscle relaxation must be achieved for this reduction technique to be successful (14). Note that during

Figure 3: (A–C) Spaso method.

Figure 5: Stimson method.

this maneuver, an inferior dislocation may be converted to an anterior dislocation. In this case, the provider should then perform an appropriate anterior shoulder dislocation reduction technique.

Initial Treatment/Return to Play

After the dislocation has been reduced, the athlete is typically placed in a sling. The athlete who has a primary dislocation will likely be in too much pain or not have enough strength or ROM to continue their particular sport. There has been some research and much debate on the standard sling versus immobilization in external rotation for anterior dislocations. Itoi (32) found immobilizing patients with primary anterior shoulder dislocation in external rotation better approximated the Bankart lesion leading to decreased recurrence of instability. Momenzadeh et al. (43) found external rotation to be the optimum position, but was unclear on the length of time the athlete should remain in the external rotation brace. Paterson et al. (49) found no benefit from immobilizing the arm in a standard sling for greater than a week. External rotation may be of some benefit but there was no difference in the rate of recurrence.

Of course, most athletes do not focus on the extent of the damage but on the length of time until they can resume playing their sport. Although it is generally accepted that surgical stabilization is the optimal treatment choice for young athletes, this may not always be possible during in-season athletics. Operative stabilization reduces recurrence substantially, from 80% to 90% down to 3% to 15%, and improves overall long-term outcomes (67). Although there is no consensus on return to play, McCarty et al. (40) provided a comprehensive review and came up with their "ideal" criteria for return to play, which includes little to no pain, near normal ROM, near normal strength, normal functional ability, and normal sports-specific skills. Buss et al. (11) evaluated the ability of in-season athletes to return to their sport after an anterior instability event with favorable results. Treatment was nonoperative with early mobilization, physical therapy, and bracing. Athletes were able to return to their sport when they have bilateral equal strength and functional ROM allowing them to play their sport or position. A Duke Wyre brace was recommended for nonoverhead sports and a Sully brace for overhead throwing athletes. Twenty-seven out of 30 athletes were able to return to their sport for all or part of the season and missed an average of 10.2 d. Ten of the 27 who returned to their sport had at least one additional instability event. Only one of the 27 athletes who returned to their sport was unable to complete the season. The decision to allow an athlete to return to athletics after shoulder dislocation must be thoroughly discussed with all persons involved. Complications of returning to sport too soon include recurrent dislocation(s), worsening of the injury, or a catastrophic injury that could prevent further participation in athletics or difficulties with daily activities. With that being said, there are a large group of athletes who are able to safely return to their sport in a relatively short amount of time with no recurrence of shoulder dislocation.

Pitfalls

Damage to the axillary nerve is the most common neurological injury after shoulder dislocation (7). The axillary nerve needs to be tested before and after reduction. This task is easily and quickly accomplished on the sideline by checking sensation over the lateral deltoid by light touch. Once the reduction has occurred, motor testing of the deltoid also should be evaluated.

Vascular injuries to the axillary artery can occur with all shoulder dislocations (7). The highest rate of injury occurs with an inferior shoulder dislocation and is reported to be 3.3% (7). Although vascular injury is rare, assessing pulses before and after reduction should always be performed.

We recommend attempting at least two different reduction methods before sending the patient to the emergency department (ED) for further evaluation and treatment. When a shoulder cannot be reduced, the provider must consider the possibility of fracture or other diagnosis and imaging should be obtained urgently.

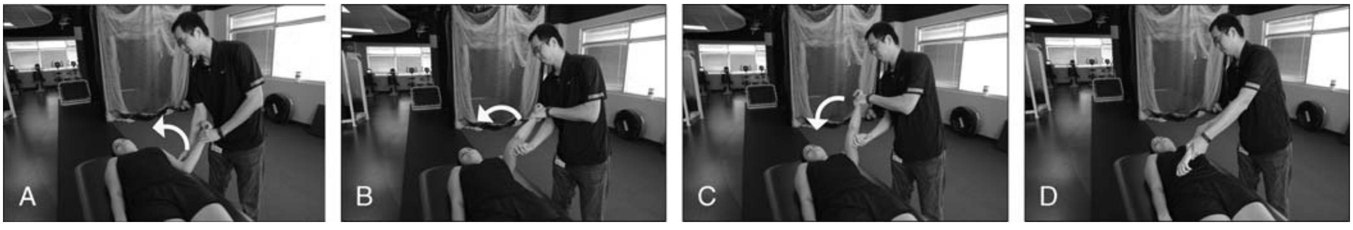

Figure 6: (A–D) Kocher method.

Figure 7: (A, B) Fast, reliable, and safe (FARES) method.

Injury to the anterior inferior labrum and anterior band of the inferior glenohumeral ligament (the Bankart lesion) commonly occurs with anterior shoulder dislocations. Studies report that the incidence of Bankart lesions with anterior shoulder dislocations is as high as 97% (6). This tissue serves as the primary static stabilizer to prevent anterior translation of the humeral head with the shoulder held at 90° of abduction. Injury to this structure leads to an increased risk of recurrent shoulder dislocation or shoulder instability (6). Hill-Sachs lesions are impaction fractures to the posterior-superior humeral head that occur when the dislocated head makes contact with anterior inferior glenoid. Hovelius et al. (30) found that the presence of a Hill-Sachs lesion leads to increased recurrent rates in young men aged 12 to 22 yr. Greater tuberosity and coracoid fractures are associated with anterior dislocations as well. Radiographs of primary shoulder dislocations should be obtained as soon as possible to ensure proper reduction and no associated fractures.

Injury to the posterior inferior labrum and posterior band of the inferior glenohumeral ligament (the reverse Bankart lesion) commonly occurs with posterior shoulder dislocations (53). Reverse Hill-Sachs lesions are impaction fractures of the anterior humeral head that occur when the dislocated head makes contact with the posterior glenoid. The incidence of reverse Hill-Sachs lesions has been reported to be as high as 86% in patients with posterior shoulder dislocations (55,71). Fractures of the glenoid rim can occur as a result of this as well. Fractures to the lesser and greater tuberosities have been reported to be as high as 42% and 23%, respectively (55).

Rotator cuff tears are commonly associated with inferior shoulder dislocations and can be seen in up to 50% of cases (14). Other associated complications with inferior shoulder dislocations are fractures of the clavicle, inferior glenoid, greater and lesser tuberosities, coracoid, and acromion (20).

Elbow

Anatomy

The elbow is a complex joint composed of three separate articulations. The ulnotrochlear, radiocapitellar, and proximal radioulnar joints all work together to allow stable flexion, extension, pronation, and supination. The proximal end of the ulna forms the olecranon, the c-shaped trochlear notch that articulates with the distal humerus. The anterior inferior portion of the c-shaped trochlear notch ends in a blunt central point called the coronoid process. This process is often fractured in posterior elbow dislocations.

The joint capsule thickens medially to form the ulnar collateral ligament. There are three distinct bands that comprise the ulnar collateral ligament (UCL). These bands attach the medial epicondyle to the coronoid and the olecranon. The lateral or radial collateral ligament extends from the lateral epicondyle proximally and distally blends into the annular ligament attaching the radial head to the ulna. The surface of the annular ligament is lined with synovium and allows the head of the radius to rotate during pronation and supination.

Mechanism

The vast majority of elbow dislocations are caused by a fall on an outstretched hand. The elbow is slightly flexed and the olecranon impacts the superior aspect of the olecranon fossa and creates a lever effect forcing the coronoid process posteriorly out of the trochlea. Posterior and posterolateral dislocations account for 80% to 90% of these dislocations (34). In high school sports, the incidence is 0.38 per 100,000 athletic exposures, with the most common sports being varsity boys' football and wrestling (19).

Sideline assessment

Because the majority of simple elbow dislocations are posterior or posterolateral, those are the only dislocations that will be discussed. Other dislocations should be managed in an emergency room after appropriate imaging has been obtained. The initial evaluation of the athlete with a posterior elbow dislocation needs to quickly assess for integrity of the neurovascular structures and bony elements. Look for paresthesias in the distal median and ulnar nerve distribution and integrity of the radial pulse. Palpate the medial and lateral epicondyles of the humerus to assess for concomitant distal humeral fracture. Concern for significant bony injury of the distal humerus or the proximal radius should preclude sideline reduction unless there is significant neurovascular compromise. Once complex elbow fracture dislocation has been clinically excluded, closed reduction can then be accomplished by one of several techniques.

Reduction techniques

The classic technique for reduction of posterior and posterolateral dislocations requires two people to accomplish. With the athlete lying supine, one provider stabilizes the distal humerus while the second provider applies in-line traction inferiorly to the proximal forearm to disengage the

Figure 8: Two-person technique for reduction of posterior and posterolateral dislocations.

coronoid process from the olecranon fossa while simultaneously applying anterior force to bring the ulna back into its anatomic position in the trochlea (Fig. 8). Another technique, preferred by this author, requires only one person to perform the reduction. The provider positions himself at the side of the patient. The provider places the posterior part of his elbow in the antecubital fossa of the dislocated elbow and then interlaces his fingers with the injured athlete. While holding the fingers tightly, the provider extends his or her wrist causing a posterior force to be applied to the distal humerus while applying longitudinal traction to the forearm (Fig. 9). The force at the antecubital fossa disengages the coronoid and allows the ulna to return to the trochlea of the humerus.

Initial treatment/return to play

After reduction, the sports medicine provider should assess for neurovascular integrity and function of the wrist flexor and extensor muscles. Typically, there is significant soft tissue swelling medially and full extension is fairly painful. Integrity of the medial and lateral collateral ligaments should be assessed at 20° of flexion and at full extension if possible (33). The athlete should then be splinted with the elbow at 90° and the wrist in neutral position. Radiographs should be obtained as soon as it is practical to assess for subtle bony injury with special attention paid to the coronoid process. Same-game return to play is very unlikely, and a period of rehabilitation is typically required to return full ROM and strength to the elbow.

Pitfalls

The most significant concern is the risk of postreduction stiffness. Loss of extension is very common and difficult to regain once it is established. Immobilization to allow soft tissue healing for a week and then aggressive ROM exercise and therapy are indicated. One protocol used no immobilization and showed excellent return to function (54). Radiographs also are important to exclude subtle bony injury that is not suspected and can reclassify a simple elbow dislocation as a complex fracture dislocation that requires operative intervention.

Wrist/Hand

For the wrist and hand, this article will focus on the most common dislocations of the hand and fingers. Hand and wrist injuries can account up to 15% of all injuries in collision sports, and approximately 50% of those injuries involve the fingers (50). This article will not discuss wrist dislocations due to the high rate of associated fractures with wrist dislocations as well as the low rate of isolated dislocations that can be safely reduced on the field without the aid of imaging or sedation (22,51).

Carpometacarpal Joint

Anatomy

Dislocations involving the carpometacarpal (CMC) joints are uncommon injuries and represent less than 1% of all hand and wrist injuries. However, up to 70% of the CMC dislocations are missed or misdiagnosed (68). Concomitant fractures also are highly associated with CMC dislocations. The relatively more mobile fourth and fifth CMC joints are more susceptible to injury than the second and third CMC joints with the fifth CMC joints being the most commonly dislocated (12). Isolated dislocations of the first (thumb) CMC joint are the most infrequently injured with fewer than 40 cases reported in the literature (48).

The fourth and fifth metacarpals are primarily stabilized by their articulation with the hamate bone with the fifth metacarpal articulation being a biconcave saddle joint similar to the thumb CMC joint. The flexion-extension arc for the fifth and fourth CMC joints are 20° to 30° and 10° to 15°, respectively. The fifth CMC joint also allows for mild rotatory motion to assist with thumb opposition (12). The thumb CMC joint is a biconcave saddle with a thickened joint capsule that is primarily stabilized by the four ligaments: volar (anterior oblique), intermetacarpal, dorsal radial, and dorsal (posterior) oblique (48).

Mechanism

An axial load onto a flexed metacarpal is the most common injury pattern, *e.g.*, punch or fall onto a clenched fist (68). The bases of the metacarpals are more commonly displaced dorsally losing their articulation stability, which leads to an imbalance of the extrinsic tendon power (12). In particular, the extensor carpi ulnaris (ECU) is the primary

Figure 9: One-person reduction technique for an elbow dislocation.

deforming force with the fifth CMC joint dislocations because the ECU inserts at the base of the fifth metacarpal (12).

Sideline assessment

Most commonly, the athlete will present with swelling, tenderness, and crepitation at the CMC joints. Swelling can be immediate and commonly hide subtle deformities or dislocations. Keep in mind that even with plain radiographs, these dislocations are commonly missed (12,68). With the fifth CMC joint dislocations, ulnar nerve injuries also are possible because of the deep motor branch's proximity to this joint (12).

Reduction techniques

Sideline reductions should be avoided because of the high rate of fractures and other associated injuries. After appropriate x-rays and diagnosis, closed reduction usually with percutaneous pinning is typically performed. The technique usually involves longitudinal traction of the metacarpal followed by pressure directed volarly on the dorsal base of the metacarpal (12). With appropriate treatment and early recognition, 87% of patients with CMC joint dislocations return to full sports without significant pain or dysfunction (68).

Initial treatment/return to play

CMC joint dislocations initially cause significant pain and disability. Return to play the same day of injury is not recommended. Assessing for possible neurovascular injury, applying ice, and splinting for comfort are the initial steps of management on the sideline (12). Urgent transport for immediate x-rays is usually not necessary unless there is evidence of compartment syndrome or other neurovascular compromise.

Pitfalls

The most common complications are due to delayed diagnosis, which can result in chronic pain, reduced grip strength, and degenerative arthritis. Up to 43% of patients with a missed single CMC joint dislocation will experience some degree of residual pain and disability (68).

Proximal Interphalangeal Joint

Anatomy

The proximal interphalangeal (PIP) joint dislocations are the most common types of finger dislocations (10). Dorsal PIP dislocations are the most common, followed by lateral, and then rarely volar PIP dislocations. The most commonly affected finger is the little finger (28). The PIP joint is a hinged joint that accounts for the 85% of the motion required to grip any object (9,50). The PIP joint is primarily stabilized by the articular surfaces of the two concentric condyles that are separated by an intercondylar notch. In addition, there are other dynamic and static stabilizers, including the central slip on the dorsal side, flexor/extensor tendons, radial/ulnar collateral and accessory ligaments, and the volar plate (9,10). The volar plate, which is commonly injured with dorsal PIP dislocations, is stabilized by the checkrein and accessory collateral ligaments (28,50).

Mechanism

Dorsal PIP dislocations occur secondary to a hyperextension of the PIP joint from an axial load to the middle phalanx. Typically, the volar plate is avulsed from the middle phalanx base and the middle phalanx lies on the dorsal surface of the proximal phalanx (9). These PIP injuries can occur with or without a small bony avulsion fracture. Most commonly, the collateral ligaments are intact and joint congruity is maintained (9). In a severe dorsal PIP dislocation, a larger bony fragment involving greater than 40% of the articular surface on the middle phalanx creates an extremely unstable joint, which may make it difficult to maintain a closed joint reduction (9).

Lateral PIP dislocations occur from a radial or ulnar stress to the PIP joint resulting in an avulsion of the collateral ligament. With more force, the volar plate also can be torn along with the collateral ligaments (9).

Volar PIP dislocations are rare, but they are typically more complicated than dorsal PIP dislocations. In simple cases, the central slip of the extensor mechanism tears form the dorsal lip of the middle phalanx. In more complicated cases, the lateral band and collateral ligaments can be torn and interposed within the joint (9).

Sideline assessment

As with all joint evaluations, locating the area of pain and performing a thorough physical examination are critical. For all PIP dislocations, active ROM of PIP will be limited. Malrotation deformities, skin integrity, and neurovascular status also should be evaluated. For simple dorsal PIP dislocations, the PIP joint is hyperextended and the middle phalanx rests on the top of the proximal phalanx with tenderness at the volar portion of the PIP joint (9,28). With lateral PIP dislocations, the middle phalanx is recognized to be on the radial or ulnar side of the proximal phalanx. Volar PIP dislocations are more subtle, but are noted when PIP is flexed and the proximal phalanx is prominently sitting on the dorsal surface of the middle phalanx (10).

Reduction techniques

Dorsal PIP reductions are performed with axial traction, slight hyperextension, and direct pressure on the base of the middle phalanx. Lateral PIP reductions are performed with axial traction of the middle phalanx with appropriate radial or ulnar stress. For the volar PIP reductions dislocations, the PIP should be flexed along with the middle phalanx traction. Keep in mind that volar dislocations are more complicated and often involve soft tissue interposition within the joint, which may prevent closed reductions (9,28,63). Simple axial traction alone should be avoided because this could lead to tightening of soft tissue and potentially prevent closed reduction (63).

Initial treatment/return to play

After all PIP reductions, the athlete must have active ROM, in particular, full extension, before considering any return-to-play possibilities. For most successfully reduced PIP dislocations, an athlete could potentially return to play the same day if he or she has minimal pain, no neurovascular compromise, full active PIP extension, and/or no rotation deformity. Buddy taping with a functional splint also should be applied before returning to the same game (63). After the game, radiographs are highly recommended. After the initial reduction and x-rays, dorsal and lateral PIP dislocations should be splinted in 20° to 30° of flexion for 2 wk to allow for healing of the volar plate. Volar PIP dislocations with an associated central slip injury should be splinted in full extension for 6 wk (10,63).

Pitfalls

Joint stiffness is the most common complication if early mobilization of the reduced PIP joint is not implemented. However, lack of adequate immobilization to allow for proper healing can result in instability and recurrent PIP dislocations (28). For dorsal PIP dislocations, swan-neck deformities can occur with untreated volar plate injuries and pseudo-boutonniere deformities can occur with contractures (28,50). Boutonniere deformities can develop secondary to central slip injuries that can occur commonly with volar PIP dislocations (50).

Metacarpal Phalangeal Joint

Anatomy

Metacarpal phalangeal (MCP) joint dislocations are less common than PIP joint dislocations secondary to the position in the hand. However, the MCP joint of the thumb is frequently injured because it is less protected and most vulnerable in abduction. The MCP joint anatomy is very similar to the PIP joint; however, the volar plate is more attenuated and not anchored by the checkrein ligaments (28). The MCP joint motion is also more complex than the PIP joint. The MCP joint allows adduction, abduction, and circumduction in addition to extension and flexion. The sagittal bands are the primary stabilizers for the extensor mechanism of the MCP joint and the proper/accessory ligaments are the primary stabilizers for radial and ulnar deviation of the MCP joint (50).

Mechanism

Similarly to the PIP joint, the MCP joint most commonly dislocates dorsally. Volar dislocations are very rare. Dorsal MCP joint dislocations occur secondary to hyperextension injuries with the second MCP joint as the most commonly dislocated joint (28,50).

Sideline assessment

Once the injured joint is correctly identified, an initial approach similar to evaluating a dislocated PIP joint should be implemented. For all MCP joint dislocations, active ROM of the joint is disrupted. The simple dislocated MCP joints will appear hyperextended from 60° to 90° and the proximal phalanx should be resting on the dorsal surface of the head of the metacarpal (39). Complex MCP dislocations do not present with the same hyperextension but display near parallelism between the metacarpal and proximal phalangeal shafts. Puckering of the skin on the palmar surface is pathognomonic for complex dislocations (39).

Reduction techniques

Unlike reducing the PIP joint dislocations, extension and traction alone should not be used to reduce MCP dislocations (39). Simple dorsal MCP joint dislocation can be reduced by flexing the wrist and PIP, then by applying steady pressure in a distal and volar direction over the dorsal base of the proximal phalanx. Complex and volar MCP joint dislocations oftentimes cannot be reduced with a closed technique (28,39).

Initial treatment/return to play

After reduction of a simple dorsal MCP joint, an athlete with active ROM, minimal pain, and/or no rotational deformity can be allowed to participate immediately. Functional splinting and buddy taping also should be applied before returning to the field of play. After the game, radiographs should be obtained. If the x-rays are negative for any additional injury, a splint or cast immobilizing the MCP joint in slight flexion for 2 wk is recommended (10,28).

Pitfalls

The treatment of MCP joint dislocations can lead to chronic joint stiffness or instability due to prolonged or inadequate immobilization, respectively. Failing to recognize concomitant fractures, complex dislocations, or other soft tissues injuries, *e.g.*, skier's thumb, are the most common pitfalls (10,39).

Distal Interphalangeal Joint

The distal interphalangeal (DIP) joints have very similar anatomy to the PIP joints; however, isolated closed simple dorsal DIP joint dislocations are quite rare. Most DIP joint dislocations are accompanied by a fracture, tendon rupture, and/or PIP joint involvement. Only a few cases have been reported in the literature over the last 75 yr (10,13). The mechanism of a dorsal DIP joint dislocation is again very similar to PIP joint dislocation — axial loading that results in a hyperextension of the distal phalanx resulting in a disruption of the volar plate (13). On presentation, the DIP joint will be hyperextended and the distal phalanx will be resting dorsally on the head of the middle phalanx. When examining the DIP joint, careful attention to possible injuries involving the terminal extensor and flexor digitorum profundus (FDP) tendons must be included as well as skin integrity. Open injuries can commonly present with a transverse laceration in the flexion crease (13). Close reductions of the dorsal DIP joint dislocations are recommended by applying axial traction and bringing the distal phalanx into hyperextension, while pushing the distal phalanx distally and volarly. After a successful reduction, return-to-play guidelines and splinting are similar to the dorsal PIP dislocations with concomitant splinting. Because isolated simple closed dorsal DIP dislocations are rare, caution is advised when attempting closed reductions without proper imaging. Missed fractures and FDP tendon injuries are the most worrisome, and detrimental complications can occur (13).

Hip

Anatomy

The dislocation of a hip is an uncommon yet dramatic injury that can occur during sideline coverage. Approximately 3% of all football-related injuries involve a hip fracture or dislocation (46). It requires urgent evaluation and management to prevent long-term complications. The hip joint is a true ball and socket joint, consisting of the head of the femur lying within the acetabulum. To help provide stability, the femur is held in place by five separate ligaments, thus making dislocation of the joint difficult.

Figure 10: Allis method.

The ligaments involved are the iliofemoral, pubofemoral, ischiofemoral, transverse acetabular, and the femoral head ligament. The iliofemoral ligament attaches to the anterior inferior iliac spine of the pelvis and the intertrochanteric line of the femur. The pubofemoral ligament originates at the superior ramus of the pubis and attaches to the intertrochanteric line of the femur. The ischiofemoral ligament connects the ischium to the greater trochanter of the femur. The transverse acetabular ligament consists of the labrum covering the acetabular notch. The femoral head ligament joins the femoral head with the transverse ligament and acetabular notch. When dealing with a dislocated hip on the field, the sciatic nerve, located inferoposterior to the hip joint, is an important landmark to evaluate. Assessing the hip vasculature, which consists of the medial circumflex femoral artery that supplies the neck and shaft of the femur, and the obturator artery that supplies the femoral head, is almost impossible on the field. However, evaluating distal neurovascular status is imperative, *i.e.*, femoral and pedal pulses as well as capillary refill, sensory, and motor function.

Mechanism

Approximately 70% of all hip dislocations are posterior, and 90% of those occur while participating in sports (1,42,72). For this injury to occur, a significant force is needed to dislocate the femoral head posterior to the acetabulum. These injuries are always considered orthopedic emergencies. American football and rugby are the sports where posterior hip dislocations are most commonly reported, followed by alpine skiing and snowboarding (46,66). The typical mechanism is forced adduction and internal rotation, with the hip in a flexed position. Hip dislocations also may occur while participating in sports with a fall forward on a knee with the hip flexed, or when an athlete sustains an impact from behind while down on their hands and knees (61).

Sideline assessment

Typically, an athlete with a dislocated hip will be found lying on the ground in immediate and severe pain. Upon evaluation of the hip, there is often limb shortening with the hip in flexion, internal rotation, and adduction (46). This usual presentation may be different if there is a concomitant fracture of the femoral head or shaft. Rapid sideline evaluation and treatment will help prevent long-term complications for the athlete. Initially, it is imperative to assess the distal neurovasculature of the injured extremity because this may necessitate a more urgent orthopedic intervention. In the majority of populated areas, emergent transport of the injured athlete to the nearest trauma center is recommended.

While on the field, if possible, place the athlete on a backboard and allow the hip to be aligned in the most comfortable position. This is usually performed with the hip in flexion and the leg adducted. If the sideline physician is comfortable and familiar with reducing a hip, an immediate on-the-field reduction of posterior hip dislocation is recommended when possible (69). Attempting to reduce a posterior hip dislocation before the onset of muscle spasm can improve pain, help with transport, and decrease the possibility of developing avascular necrosis (AVN). However, posterior hip reductions will often require intravenous pain medications, muscle relaxants, and conscious sedation because of the significant amount of pain and muscle spasm. Multiple attempts at closed reductions of hip dislocations are associated with poor outcomes and should not be attempted without an orthopedic surgeon consult (69).

Reduction techniques

There are four different techniques for reduction of a posterior hip dislocation: Allis, Stimson, Bigelow, and Whistler methods. No one method has been proven to be superior. The Allis method involves an assistant stabilizing the pelvis with the patient in a supine position by applying downward pressure on the anterior superior iliac spine. The operator then applies an axial traction in line with the deformity by pulling with their hands from behind the flexed knee. While keeping the traction, the hip is gently flexed to 90° and then internally and externally rotated until reduction occurs (Fig. 10). This method requires two care providers but allows for easy monitoring of the patient's airway during the reduction (69). The Stimson method involves placing the patient in a prone position with the affected hip hanging over the edge of a bed. Downward traction is applied to the leg while an assistant applies stabilizing pressure to the pelvis (Fig. 11). The challenges with this reduction technique are that it also requires two people and it may be difficult to

Figure 11: Stimson method.

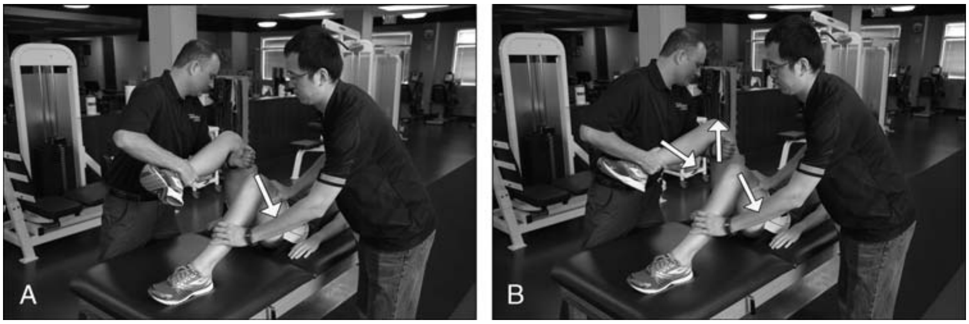

Figure 12: (A, B) Bigelow method.

place the patient in a prone position (69). The Bigelow maneuver involves an assistant providing downward pressure on the anterior-superior iliac spine while the physician pulls in-line traction, while flexing the hip 90°, while applying internal rotation and adduction until reduction occurs (Fig. 12A–B). The Whistler method involves the patient in a supine position with the unaffected knee flexed to 120° by placing the unaffected foot on the table. An assistant may stabilize the unaffected foot and pelvis during reduction. While standing on the affected side, the operator reaches one hand under the affected knee and places the other hand onto the affected ankle. Then the operator flexes the dislocated hip to 90° while pulling down on the lower leg. During this process, the operator internally and externally rotates the hip until it reduces. This method requires a lot of practice and skill, but it can be performed with one person and also allows for easy monitoring of the patient's airway during the reduction (45). Regardless of reduction technique, urgent reduction is imperative because hips that take over 6 h to reduce have significantly greater chances of chronic complications.

Initial treatment/return to play

After hip dislocations, return to play is impossible the same day of injury and challenging with significant time. A posterior dislocation will be a season- and often career-ending injury for many athletes. A quick reduction can prevent long-term complications, and a good therapy program can improve overall function and ability to resume athletic activity.

Pitfalls

The most common complication of a hip dislocation is posttraumatic degenerative changes (46). AVN of the femoral head is related to the length of time until hip reduction (46). When a hip reduction occurs within 6 h, there is only a 5% risk of AVN, yet if the reduction is delayed over 6 h, the risk of AVN increases up to 60% (58). Other complications to consider include life-threatening internal organ damage, bleeding, and shock due to the force needed to dislocate the hip. Injury to the sciatic nerve also can be seen in 10% to 14% of the posterior hip dislocations. Fractures to the pelvis and acetabulum as well as the femoral head, neck, and shaft can be seen with hip dislocations. Other chronic complications include recurrent dislocations, posttrauma arthritis, and myositis ossificans of the thigh and buttock (45).

Knee

The knee is a hinge joint with only one plane of free movement. It is able to twist and pivot from side to side very slightly. There are two main articulations in the knee, which can both dislocate. One is the tibiofemoral joint, which is commonly referred to as the knee joint, and the second is the patellofemoral joint, which is commonly referred to as the kneecap.

The dislocation of the tibiofemoral joint or a knee dislocation is one of the more serious dislocations an athlete can sustain. There can be nerve and blood vessel damage associated with this injury, which can lead to serious consequences including loss of a limb (59). Patellar dislocations are much more common and not nearly as serious.

Tibiofemoral Joint

Anatomy

There are four main structures that contribute to knee stability. The anterior cruciate ligament provides support for anterior translation of the tibia in relation to the femur. The posterior cruciate ligament prevents posterior translation of the tibia in relation to the femur. The medial and lateral collateral ligaments provide stability to the joint from side to side stresses. Minor stabilizers of the joint include the knee capsule, the posterior oblique ligament, the posterolateral corner, the meniscii, and the patellar and hamstring tendons.

The common peroneal nerve courses over the fibular head. It provides sensation for the dorsum of the foot and innervates the anterior and lateral compartments of the lower leg responsible for dorsiflexion of the ankle. Small studies have shown injury rates of 25% in dislocations (44). Popliteal artery is a continuation of the femoral artery. It courses through the popliteal space and supplies most of the lower leg muscles. It is injured in up to 40% of knee dislocations (63).

Mechanism

Knee dislocation requires a large amount of force. Generally, multiple ligaments must be torn before the knee dislocates (59). This can occur during motor vehicle accidents. When this occurs, it is termed a high-velocity injury. Low-velocity injuries occur during sporting events and what is commonly seen on the sidelines. The true incidence of knee dislocation is unknown because of spontaneous relocations before assessment (52). There is a relatively new mechanism described with obese individuals with low impact running or falls called ultra-low-velocity dislocations (2).

There are five different directions the tibia can translate in relation to the femur: anterior, posterior, medial, lateral, and rotational. The rotational type is subdivided to anteromedial, anterolateral, posteromedial, and posterolateral. They are all treated the same except for posterolateral dislocations, which is unable to be reduced without surgery (27).

Sideline assessment

Because of the complications, assessment of pulses and nerve function are critical in the initial assessment. The direction of the dislocation must be assessed and reduction performed immediately if possible. Ankle–brachial index (ABI) and pedal pulses are routinely used to determine intact popliteal artery. Pedal pulses have a 75% positive predictive value (PPV) and 93% negative predictive value (NPV) for detecting vascular injury (4). Having a normal ABI is a good indication that there is no arterial injury (41). Typically, ABIs are difficult to obtain on the sideline without a portable Doppler, and pedal pulses are not reliable enough to exclude damage.

A focused neurological examination including gross sensation and ability to dorsiflex can be performed on the sideline. After this injury, patients are unable to bear weight and functional testing is unable to be performed.

Almost all of the knee dislocation types are reducible on the field. Only posterolateral dislocations are unable to be reduced on the sideline and require open relocation. This type of dislocation is associated with button holing caused by the medial condyle sticking through the medial capsule and the medial collateral ligament (MCL) is within the joint (27).

Reduction techniques

On-field reduction of the knee should be done immediately. Longitudinal traction is usually sufficient as the knee is lax because of the lack of normal stabilizing ligaments. One provider will hold the femur while the other holds the tibia and provides increasing traction inferiorly. If that does not work, place traction in the opposite direction as the dislocation. For example, for anterior dislocations, posterior force will be placed on the tibia in relation to the femur. There should be a clunk that is felt signaling reduction. Avoid pressure to the popliteal fossa to prevent further injury to the popliteal artery (62). Most knee dislocations can be reduced using these techniques, but if a reduction is not achieved after one or two attempts, then the knee should be immobilized and the patient transported to the ED.

Initial treatment/return to play

Once reduced, the knee should be immobilized in a slight flexion of 10° to 15°. Because of the high incidence of arterial injury, arteriography or computed tomography (CT) angiography of the popliteal artery should be performed as soon as possible, and immediate referral to vascular surgery is needed if there is any sign of arterial injury. Patients are typically monitored for 24-h postinjury with frequent examinations of vascular status.

Knee dislocations are often devastating injuries, and questions about return to play frequently revolve around "if" the athlete will return to play and not "when." Surgery is needed to reconstruct or repair the multiple structures injured, and rehabilitation times vary from 6 months to 1 yr or more.

Patellofemoral Joint

Anatomy

The patella is the largest sesamoid bone in the body. It is attached to the quadriceps muscle proximally through the quadriceps tendon and to the tibia distally through the patella tendon. The patella is attached medially to the medial patellofemoral ligament (MPFL). The medial and lateral retinaculum provides added horizontal stability. Most dislocations occur laterally because of natural biomechanics of the patella (5). The patella normally sits within the femoral groove. Conditions such as patella alta or abnormal flattening of the groove will predispose patients to dislocations (65). Dislocation is commonly confused with subluxation, which is an increased lateral shift of the patella. Medial patellar dislocation has been described in literature occurring after lateral release procedures and one trauma case, but this is rare (37).

Mechanism

There are two main injury patterns that cause patella dislocations. One is a twisting injury with the foot planted such as landing in basketball or gymnastics. Internal rotation combined with valgus stress creates a torque on the knee that tears the MPFL and medial retinaculum. The other mechanism is a direct blow to the knee, but that is less common (5).

Sideline assessment

Athletes will commonly feel a pop or feel the knee give way. Visual assessment of the knee will show the knee to be flexed and the patella to be sitting on the lateral side of the knee. Palpation of the patella in an abnormal location and lack of mobility are associated with dislocation. An athlete will be tender along the medial portion of the knee at the MPFL and swelling will develop rapidly.

Reduction techniques

Reduction of the patella before radiographs are obtained has been found to be safe and is recommended (36). With the patient supine, gentle pressure pushing the patella medially while extending the knee will guide the patella back in

Figure 13: Technique for reduction of the patella.

place (Fig. 13). This is usually one of the easier joint dislocations to reduce, but referral to the ED is needed if the patella is unable to be reduced.

Initial treatment/return to play

Most athletes will have extensive swelling and disability after their initial patellar dislocation; however, recurrent dislocators often have little pain and swelling after the patella is reduced. For the first-time dislocator with marked pain and disability, the knee should be iced and immobilized once the patella is reduced. Anti-inflammatories and limited weight bearing will help as well. The athlete will need to undergo rehabilitation before returning to play. Once the athlete has full ROM, normal strength and function, and minimal or no pain, they can return to play in a patellar stabilizer brace. This process usually takes 4 to 6 wk (5).

Recurrent patellar dislocators can many times return to play immediately after their patella is reduced, but they need to first be assessed on the sideline to ensure that they have full ROM, normal strength and function, and minimal or no pain before being allowed to return to play. Surgery can successfully stabilize the patella for athletes that have recurrent patellar instability who no longer wish to live with the problem (47).

Foot/Ankle

For the foot and ankle, this article will focus on subtalar dislocations and those joints more distal in the foot. Because the ankle joint is inherently stable, it requires an extremely significant force to dislocate the joint. Therefore, it is extremely unusual to see an isolated ankle dislocation without the presence of a fracture.

Subtalar Dislocations

Anatomy

The subtalar joint has three facets: the posterior, middle, and anterior. These articulate with the calcaneus resulting in inversion and eversion of the hindfoot. There is some degree of bony stability to the joint as well as an extensive capsuloligamentous complex. These soft tissue supports include the interosseous ligament, the superficial deltoid ligament (medial), and the calcaneofibular ligament (lateral).

Figure 14: Technique for reduction of subtalar dislocation.

Mechanism

The majority of subtalar dislocations are the result of high-energy injuries (8). About 85% of subtalar dislocations are medial, whereas the remaining 15% are lateral (26). Lateral subtalar dislocations are likely to be due to extremely high-energy trauma such as a fall from a height or a motor vehicle accident. Lower energy events, such as a twisting injury during a sporting event, are more likely to result in a medial subtalar dislocation.

Sideline assessment

Subtalar dislocations present with an obvious hindfoot deformity with the heel being displaced either medially or laterally in relation to the leg. As with all joint dislocations, thorough evaluation of soft tissue integrity and distal neurovascular status is paramount. Distal pulses are palpated and the presence of normal capillary refill is confirmed. Sensation is assessed before any attempts at closed reduction.

If addressed immediately, a closed reduction can often be performed on the sideline. It is reasonable to attempt a single sideline reduction before immobilizing the limb and transporting the patient to the emergency room. If a nonforceful attempt at reduction is unsuccessful, then further attempts are not indicated until x-rays have been obtained and the patient has been sedated in the emergency room.

Reduction techniques

The majority of subtalar dislocations can be reduced using closed methods. The knee is flexed to relax the pull of the gastrocnemius complex on the hindfoot. The deformity is accentuated and then reversed while distal traction is applied to the heel (Fig. 14). After the reduction, a short leg splint is applied and the patient is sent for imaging studies to confirm the reduction. A postreduction neurovascular examination is performed before sending the patient to the emergency room.

Initial treatment/return to play

There is a high rate of associated hindfoot fractures with subtalar dislocations. Studies have suggested a fracture rate of greater than 50% (8). Many of these small osteochondral fractures do not show up on plain x-rays. Therefore, a postreduction CT scan is indicated for these injuries. These patients are typically immobilized for 6 to 8 wk, and progression of weight bearing is dependent on the status of associated fractures.

Pitfalls

Joint stiffness is the most common complication of subtalar dislocations. Multiple follow-up studies have found arthritic changes localized to the subtalar joint (18). Despite stiffness, most patients who have sustained subtalar dislocations experience minimal disability once healed (73).

Metatarsophalangeal Dislocations

Anatomy

The metatarsophalangeal (MTP) joint is formed by the articulation of the concave metatarsal head and the convex proximal phalanx. Soft tissue supports include the medial and lateral collateral ligaments and the strong plantar plate. The plantar plate has a loose connection to the metatarsal neck and a stronger attachment to the proximal phalanx. The dorsal capsule is quite weak. The dorsal extensor tendons and the plantar flexor tendons provide additional soft tissue restraint to the MTP joints. The hallux MTP joint also features the medial and lateral sesamoids.

Mechanism

The MTP joints usually dislocate in a dorsal direction. This typically occurs when an axial force is applied to a hyperdorsiflexed forefoot. An example would be when an athlete has the heel of a plantarflexed foot stepped on by another participant. For dislocations of the hallux MTP joint, the sesamoid complex also may be involved in the form of injury of the intersesamoid ligament and/or fracture of one or both of the sesamoids.

Sideline assessment

Dislocated MTP joints will present with a hyperextended toe in addition to a prominent metatarsal head on the plantar aspect of the forefoot. As with other dislocations, the neurovascular status of the athlete's forefoot should be established. These dislocations are rarely open.

Reduction techniques

In the majority of cases, these dislocations can be reduced using closed methods. The technique involves exaggerating the dorsiflexion deformity followed by pulling the proximal phalanx in a plantar direction to clear the metatarsal head. Postreduction plain films are obtained to confirm the reduction and to rule out associated fracture or intraarticular loose body.

Initial treatment/return to play

After reduction of a simple dislocation, the patient is required to wear a hard sole shoe and is allowed to bear weight as tolerated. After 3 to 4 wk as swelling and pain have subsided, the athlete is allowed to resume normal shoewear and to progress activity as tolerated.

Pitfalls

The majority of these injuries heal uneventfully with no long-term disability. The exception can be the great toe, which sometimes shows radiographic evidence of hallux rigidus in years after this injury.

Interphalangeal Dislocations

Anatomy

Interphalangeal (IP) dislocations in the toes are uncommon injuries in sport given the protection afforded to the toes by the shoewear. The long extensor tendon crosses the IP joints dorsally, whereas the long flexor tendon travels underneath. The dorsal joint capsule is the weakest area given the medial/lateral collateral ligaments as well the relatively strong plantar plate. Because of this area of relative weakness, the majority of IP dislocations are directed dorsally.

Mechanism

The majority of IP dislocations involve the hallux and the fifth toe (70). These typically are hyperextension injuries.

Sideline assessment

Dislocated IP joints will present with a hyperextended toe. The neurovascular status of the forefoot is assessed. Similar to MTP dislocations, IP dislocations are rarely open.

Reduction techniques

Closed reduction is typically successful. This involves exaggerating the deformity, applying traction, and then correcting the deformity. Direct manual pressure over the deformity can assist in bringing the joint back into alignment.

Initial treatment/return to play

Once reduced, the toe is buddy taped to the adjacent toe and the athlete is placed into a stiff sole shoe. Immediate activity as tolerated is allowed.

Pitfalls

It would be extremely unusual for an IP dislocation to cause any long-term disability.

Conclusion

The sideline management of dislocations is extremely complex and challenging for sports medicine providers. It requires prompt assessment of neurovascular status, prompt reduction techniques, and prompt assessment of the functional ability of the athlete by the sideline provider. Because of the complexity of sideline joint dislocations and lack of sideline imaging, appropriate education and experience of the sports medicine provider are vital to safely assess these athletes and, in turn, allow for their safe and quick return to play as well as to minimize complications.

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