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Extremity trauma: field management of sports injuries

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Abstract Traumatic injuries to the extremities are common in athletic competitions. The practitioner providing coverage of sporting events must be prepared to diagnose and provide initial treatment of these injuries. A thorough history and physical examination should result in a provisional diagnosis. Many injuries will require subsequent radiographs or orthopedic consultation. Limb threatening emergencies are rare but must be promptly recognized and referred to a hospital. Early treatment can protect athletes from further injury and may hasten their return to competition. Some athletes with extremity trauma can return to the contest, but this decision must be made on an individual basis.

Keywords On-field management · Extremity injuries · Athletes

Introduction

A variety of health-care practitioners provide event coverage to athletes, including emergency medical services personnel, athletic trainers, primary care physicians, and orthopedic surgeons. Although these practitioners have different levels of experience and training, the athlete's safety must be paramount to anyone providing medical coverage of sporting contests. Trauma to the extremities occurs frequently during athletic competition, particularly in contact sports. In order of importance, the goals of on-field treatment of extremity trauma are to (1) prevent further injury; (2) minimize the zone of injury; (3) decrease pain; (4) promote healing; and (5) allow a safe return to athletic competition. In order to achieve these goals, the provider must arrive at a provisional diagnosis, provide initial treatment, determine if an urgent referral is needed for further evaluation or management, and finally make a decision as to whether an athlete can safely return to play during the contest. The focus of this article will cover the general principles that physicians with general orthopedic training should use in the on-field evaluation and management of extremity trauma in athletes. Providers with less orthopedic knowledge may need to refer patients more frequently and those with more orthopedic training may be able to provide more specialized care than described here. Acute treatment of specific musculoskeletal injuries is beyond the scope of this article, although it is our goal that the general principles in this article will guide the reader to additional learning for specific management.

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Types of extremity injuries

When evaluating extremity trauma, we suggest an anatomic approach considering all of the different types of tissues found in the extremity. Even though the extremities are primarily composed of musculoskeletal tissue (bones, muscles, tendons, ligaments, and cartilage), the physician must also be prepared to manage injuries to the skin and to neurovascular structures. The skin can be lacerated from external (eg, equipment) or internal (eg, fractured bone) objects. Although rare, arterial lacerations or occlusions can result in diminished blood flow that may jeopardize survival of the extremity. Nerve trauma can result from lacerations, stretch injuries, compression, or contusions. Bones may be fractured and joints may dislocate as a result of supraphysiologic loads that can incur in athletic competition. Ligament sprains occur with excessive tensile loads; these sprains are commonly seen about the ankle, knee, elbow, and hand. Musculotendinous units also fail under tension and excessive loads can result in muscular strains or complete tendon tears. Intraarticular damage can result in meniscal tears, labral tears, and chondral injuries, which are frequently caused by excessive compression or shear forces. All types of tissue in an extremity can sustain contusions from direct contact from another player, an object, or the ground. Physicians providing game coverage should be prepared to evaluate and provide initial management for the entire spectrum of athletic extremity injuries.

Assessment

Evaluation of on-field extremity injuries begins with a thorough history. First, have the athlete identify the specific nature and location of their complaint, the mechanism of the injury (eg, contact vs noncontact, rotational vs axial loading), and the severity of the pain. The team physician should ask the athlete if they are able to weight bear on an injured leg or move an injured arm. Inquire about functional deficits such as instability, mechanical blocks to joint motion, numbness, and weakness. The athlete should be questioned about any history of previous injuries to the injured and opposite extremity. A thorough history will yield a differential diagnosis and help guide the physical examination.

The physical examination is first directed to the entire injured extremity. The physician should first survey for open injuries, any gross deformities, and soft tissue swelling, thereby helping to focus the exam. The surrounding joints should then be measured for active and passive range of motion and compared with the contralateral side. During this examination, note any crepitus or limitation of motion. Carefully palpate the injured area to identify any crepitus, swelling, or deformity. Any areas of tenderness should be correlated with underlying anatomic structures. Examine all adjacent ligamentous structures with stress testing, and compare with the patient's uninjured side, taking note of any increased laxity. Assess the strength of major muscle groups in the extremity and contrast with the opposite extremity. Palpate for defects of the major tendons about the joint. Perform specific provocative tests as indicated (eg, McMurray test for meniscal tear or jerk test for posterior shoulder instability). After this initial evaluation, the team physician should have a presumptive diagnosis that describes the type of injury and the anatomic structure(s) injured. For example, the practitioner would diagnose a knee MCL grade 2 sprain rather than a knee sprain; a quadriceps contusion rather than a bruised leg; and a supraspinatus tendon tear rather than a shoulder strain. It is important to remember that multiple structures can be injured in a single traumatic event. Finally, the examiner should develop a differential diagnosis that includes other possible injured structures.

As part of the survey of the injured extremity, a careful neurovascular examination of the distal extremity should be performed. A thorough neurologic examination includes both motor and sensory examination of the major peripheral nerves the in the extremity. Neurologic injuries can occur from contusions, stretch injuries, and lacerations, but the examiner must always perform a careful spine evaluation to rule out central lesions [1, 2]. Observation is the initial treatment for the majority of extremity neurologic injuries [2]. Major arterial pulses must be palpated and any asymmetry to the uninjured extremity noted. Signs of extremity ischemia include diminished pulses, pallor, cold, pain, and diffuse paresthesia [3]. Fortunately, limb ischemia is rare with most athletic injuries. However, arterial injuries can occur in specific injuries such as dislocations of the knee or elbow, and with long bone fractures [3]. Any suspicion of vascular compromise on physical examination requires immediate transportation to a medical center for additional evaluation and possibly invasive treatment. Failure to restore flow to an ischemic extremity within 8 hours often necessitates amputation [4].

The physician must also be aware of the possibility of a compartment syndrome in an injured extremity. Compartment syndrome occurs when the pressure within a fascial compartment of muscle increases higher than the capillary pressure in that compartment, which results in ischemia and eventual damage to those muscles [5]. In contrast to vascular ischemia, the typical signs of ischemia (absent pulse, pallor, coolness, paresthesias) are not seen in acute compartment syndrome. Key findings on physical examination are pain out of proportion to the injury and a marked increase in pain with passive stretch of muscles within the compartment [6]. Compartment syndromes are most common in the lower leg and are frequently associated with tibia shaft fractures. However, they can also occur in the thigh, buttocks, or forearm and can occur without fracture, secondary to severe muscle contusions.

Further assessment of injured extremities may require x-ray imaging. On-site access to radiography is rare except at some collegiate and professional stadiums. The physician should refer all athletes with suspected fractures to a medical facility for radiographic confirmation; they should not return to play. The practitioner can frequently diagnose fractures because of gross deformity, crepitus, point tenderness, and inability to bear weight. The physician should be familiar with guidelines for determining when radiography is necessary. The Ottawa Rules are useful tools to help determine the need for radiography for knee injuries (Table 1) [7] and for foot and ankle injuries (Table 2) [8]. Several other authors have also provided specific algorithms to help guide the use of radiography [7, 9, 10•]. When in doubt, it is best to obtain radiographs to rule out a fracture [10•, 11, 12]. Radiographs should also be obtained for all athletes who have sustained joint dislocations or ligamentous injuries with gross laxity to look for associated bony avulsions or osteochondral fractures. The need for additional imaging (CT scans, MR imaging, etc)

Table 1 The Ottawa knee rules criteria

(1) Patient age 55 years old or greater
(2) Isolated tenderness at the patella
(3) Tenderness at the head of the fibula
(4) Inability to flex the knee to 90°
(5) Inability to bear weight for 4 steps (2 steps with each leg) immediately after the injury and in the emergency department

A dedicated knee series is indicated if the patient has knee pain with any of the above criteria [7]

should be at the discretion of physicians with expertise in management of those specific musculoskeletal injuries [11].

Treatment

The practitioner should apply a system of triage for treatment. The team physician must determine what injuries need emergent transfer to a medical center, injuries that may be referred after removal from play and stabilization, and finally, injuries that can be evaluated for return to play. Fortunately, the majority of athletic injuries do not require emergent transportation to a medical center. However, this is required in cases of suspected vascular injuries, long bone fractures, open fractures, open joint injuries, and major joint dislocations that cannot be reduced [12, 13••]. If an ambulance is not on site at the athletic event, the team physician should have a plan in place to emergently transport severely traumatized players. Injuries that obviously require removal from play, but do not threaten immediate morbidity to the patient, can be stabilized and undergo additional evaluation and definitive treatment following the game or within the next few days. Some examples of such injuries are hand and foot fractures, knee ligament sprains, reducible dislocations, and musculotendinous injuries.

Table 2 The Ottawa foot and ankle rules criteria

For the ankle:
Pain in either malleolus plus 1 of the following:
(1) Bone tenderness at tip of lateral malleolus or along posterior edge within 6 cm proximal to tip of malleolus
(2) Bone tenderness at tip of medial malleolus or along posterior edge within 6 cm proximal to tip of malleolus
(3) Inability to bear weight both immediately after the injury and in the emergency department
For the foot:
Pain in the midfoot plus 1 of the following:
(1) Bone tenderness over the base of the fifth metatarsal
(2) Bone tenderness over the navicular bone
(3) Inability to bear weight both immediately after the injury and in the emergency department

A dedicated foot or ankle series is indicated if the patient has foot or ankle pain and any of the above criteria [8]

A difficult decision for practitioners is often in the athlete with some functional limitations who might be able to return to play. There are no specific guidelines established and the practitioner must evaluate each injury and athlete on an individual basis. The physician must keep in mind the general principles of extremity trauma when making these decisions [12, 14, 15]

In the assessment of open injuries, the physician must look for damage extending to bone, joint, or neurovascular structures. All lacerations should be examined, gross debris should be removed, and the lesion should be thoroughly flushed with sterile normal saline or water. Small lacerations may be closed with steri-strips or butterfly bandages, but larger lacerations may require suture closure in a sterile environment. Lacerations should have antibiotic ointment and a sterile dressing applied to prevent contamination. Deep or grossly contaminated wounds may benefit from broad-spectrum oral antibiotic treatment. Lacerations associated with a neurovascular deficit or in conjunction with a suspected fracture, deep lacerations, and lacerations near tendons, ligaments, or joints require transfer to a hospital for additional management. Surgical debridement and early administration of intravenous antibiotics in open fractures or open joints minimizes the risk of infection [16]. Lacerations caused by teeth will require antibiotic coverage for Eikenalla bacteria, preferably an oral cephalosporin or tetracycline [17].

Sideline treatment of closed fractures is focused on preventing the injury from becoming an open fracture and minimizing the risk to neurovascular structures from the splintered bone ends [11]. The team physician may attempt to reduce markedly displaced fractures prior to obtaining initial radiographs. Gentle application of longitudinal traction in line with the proximal extremity usually improves alignment and will help protect surrounding soft tissues. Reduction should only be attempted once as there may be a soft tissue block to reduction, and additional attempts may cause further damage. A postreduction neurovascular examination is mandatory and any change in neurovascular status requires urgent transfer [11, 12]. After reduction, the physician should immobilize the fractured bone as well as the adjacent joints [11, 18]. Immobilization, ice, and elevation can reduce the pain and swelling associated with fractures and allows early treatment of fractures requiring surgery (Fig. 1). Fingers and toes can be adequately immobilized using buddy taping to an adjacent digit [19, 20]. More proximal fractures can be immobilized using prefabricated cardboard, vacuum beanbag, or well-padded custom fiberglass/plaster splints [18]. Clavicle, scapula, and humerus fractures can be safely immobilized with a sling and swathe [21]. Athletes with lower extremity fractures should be placed non-weight bearing on crutches. Femur fractures are difficult to adequately immobilize and can be associated with severe blood loss; the athlete with a suspected femur fracture should be urgently transferred by ambulance to a hospital [12]. Fractures of the carpal bones (eg, scaphoid [22]) and midtarsal region (eg,

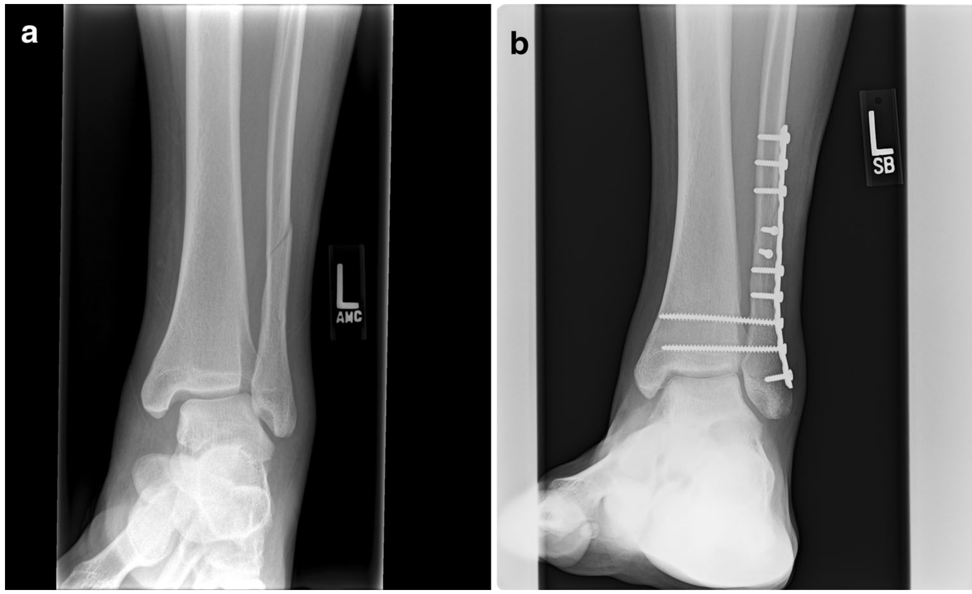

Fig. 1 A 20-year-old male football player sustained a twisting injury to the left ankle when being tackled. He was unable to bear weight on his left leg. Examination on the field showed severe tenderness over the deltoid ligament, the syndesmosis, and the distal fibular shaft. Crepitus was also present over the fibula. He was removed from play and PRICE therapy was initiated. Radiographs were obtained. An A/P radiograph (**a**) demonstrates a distal fibular shaft fracture, widening of the syndesmosis, and increased medial joint space. Immediate PRICE therapy minimized the soft tissue trauma and allowed early surgical stabilization of his injuries (**b**)

talus fracture, Lisfranc fracture [23, 24]) can be difficult to diagnose on physical exam but can have significant morbidity. Significant tenderness in these areas should have further imaging and orthopedic evaluation. All patients with fractures or suspected fractures should have an early referral to an orthopedic surgeon for definitive management.

Joint dislocations often occur during athletic events. Dislocations of the glenohumeral joint of the shoulder are common, most frequently in the anterior-inferior direction. Numerous reduction techniques have been described; most utilize some form of axial traction with gentle external rotation and abduction [13••, 25]. Extension dislocation of the phalanges may also occur, and reduction is performed by gently exaggerating the deformity, applying axial traction, and then correcting the deformity [13••]. Less common dislocations are higher energy. Hip dislocations in sports usually occur in the posterior direction as a result of a fall onto a flexed knee and hip. These represent a medical emergency and emergent transfer to a hospital should be arranged. Reduction should be attempted only with adequate sedation and imaging, and a postreduction CT is mandatory to identify any bone or cartilage fragments remaining in the joint [26]. Dislocation of the knee joint may not always present with gross deformity; any knee with gross laxity in multiple planes should be assumed to be a knee dislocation. Given the possibility of vascular compromise in knee dislocations, all suspected knee dislocations should be referred to a medical center for additional evaluation [27]. Elbow dislocations arise from injuries to multiple supporting ligaments and can occur in conjunction with radial head or coranoid process fractures. The injury is adjacent to all the neurovascular structures crossing the elbow and neurovascular injury can occur [28]. A single reduction may be attempted with longitudinal traction and alignment of the forearm to the humerus. If the reduction is successful, the athlete should be referred for imaging within a few days [13••]. If the provider is unable to reduce the elbow joint, prompt referral to a hospital for further evaluation and treatment is required. Carpal dislocations may also occur with or without an associated fracture. They most commonly occur through the proximal carpal row in a perilunate pattern or in a trans-scaphoid perilunate pattern. In the setting of severe pain and deformity about the wrist, urgent referral is recommended for additional imaging and a closed or open reduction [29]. With all dislocations, reduction should only be attempted by an experienced physician, the neurovascular status must be checked both before and after reduction, and prompt referral to medical center must occur when neurovascular injury is present or likely [13••]. All irreducible dislocations should be promptly referred to a hospital where a closed or open reduction can be performed to minimize articular cartilage damage. The length and type of immobilization, the need for operative treatment, and the criteria for return to play will differ greatly between different dislocated joints.

Initial treatment of ligament sprains depends on the joint involved and the severity of the sprain. A careful examination must be made of other ligaments supporting the injured joint, as significant injury to one ligament often involves an injury to another, typically resulting in gross instability of the joint. For example, high-grade MCL knee injuries often have associated ACL tears. These Grade III lesions display a marked increase in laxity and require removal from play. Grade I lesions display no increased laxity, and the athlete may return to play after symptomatic and supportive care. The difficulty is in determining whether Grade II lesions, with a mild increase in laxity, can return to play [30, 31]. If the injured joint can be adequately protected with taping or bracing and the athlete can perform the functions necessary to compete, return to play may be permitted. Grade II lateral ankle sprains [32] and interphalangeal joint sprains [33] are examples that may permit a return to play with adequate taping or bracing. Conversely, Grade II acromioclavicular joint sprains are difficult to protect and usually cause significant pain and weakness that prevents immediate return to play [34].

Complete tendon tears cause severe functional limitations and require removal from play. The joint that the tendon crosses should be immobilized for comfort and to prevent further injury. For example, the ankle joint should be immobilized following an Achilles tendon rupture. Other tendon tears seen in athletics are patellar tendon ruptures, rotator cuff tears, and distal biceps tendon ruptures [35–37]. When a tendon tear is diagnosed, radiographs are necessary to identify any bony avulsions. Early orthopedic referral is prudent to discuss surgical repair. Muscle strain injuries are successfully treated nonoperatively, but the time to return to full function can vary greatly. Muscle strains should be treated with the PRICE protocol to limit the zone of injury. Patients with hamstring, quadriceps, and gastrocnemius strains should initially be placed on crutches. A sling can provide protection for biceps, triceps, and pectoralis strains. A course of physical therapy is usually required before the athlete can return to competition. Aggressive early treatment of muscle strains can often allow the athlete to progress faster with the rehabilitation program and hasten return to full activity.

Muscle contusions are traumatic blunt injuries to muscle bellies. Physical exam will reveal tenderness to palpation at the site of trauma, weakness and pain with resisted activation, and superficial ecchymosis at the injury site. Contusions are treated symptomatically with ice and compression. The area should be generously padded if the athlete is returning to competition. Most athletes with contusions can return to play if pain and strength allow this [38]. The practitioner should be aware that severe quadriceps and brachial contusions can develop heterotopic ossification. Having the athlete rest with the injured muscle under maximum tension can limit hematoma formation and lessen the chance of myositis ossificans. For severe contusions, indomethacin should be given because of its inhibitory effect on heterotopic ossification [39].

Patients with meniscal tears present with joint line pain and a knee effusion. Small meniscal tears may produce only mild symptoms and the athlete may not present until after the event. Patients with larger displaced meniscal tears can present with a “locked” knee, which prevents participation. MRI is necessary to confirm meniscal tears. Locked meniscal tears are difficult to unlock without anesthesia. The athlete should be promptly referred for surgical treatment [40]. Shoulder labral tears may also not have disabling symptoms. There is pain with activity and a sensation of instability with extremes of motion. Depending on the sport and the functional limitations, the athlete may be allowed to continue participation. Again, MRI is required to confirm the diagnosis and treatment is dependent on the functional limitations of the athlete [41, 42].

Return to play criteria

The major principle in determining return to play is to protect the athlete from further injury. Major injuries (eg, long bone fractures, tendon tears, major joint ligament tears) cause such severe pain and functional deficits that it is obvious to all that the athlete has to be removed from competition. Decisions on return to play from lesser injuries need to be made on a case-by-case basis [14]. Pain from the injury will often prohibit participation. Ice and oral analgesics can be used to help reduce the pain but the physician should avoid injecting local anesthetics to help an athlete return to a contest. Any demonstrable weakness on physical examination suggests that the athlete will be unable to adequately protect the injured area during competition and will risk further injury [12, 14]. Bracing, taping, or padding can help protect an injured area adequately to allow an athlete to return to the field. The athlete should be involved in the return to play decision. The practitioner must resist any pressure from players, family members, or coaches and make the decision on return to play based on what is best for the injured athlete.

Many athletes with extremity trauma can quickly return to play with adequate protection and after demonstrating functional abilities on the sidelines. For example, a soccer player with a Grade II anterior talo-fibular ankle sprain can be taped for support of the injured ligament and allowed to return to play after successfully completing a series of sideline running and cutting drills. For sports that involve running, jumping, and cutting, lower extremity injuries affect function more than upper extremity injuries. Often the decision on return to play will vary according to the sport and position of the athlete. A football lineman who sustains an index finger PIP dislocation can return after closed reduction and buddy taping whereas a volleyball setter with the same injury and treatment will probably be unable to effectively participate. The role of the medical provider is to decide if it is safe for the athlete to return; then the coaching staff will decide if the athlete can function at the necessary level for effective competition [14, 15].

Conclusions

Sideline management of extremity trauma is an important role for the practitioner providing medical coverage of sporting events. With a careful history and thorough physical examination, one should be able to arrive at a provisional diagnosis or differential. Only a handful of extremity injuries require emergent transfer to a hospital, but it is critical that the practitioner recognize these injuries. Many extremity injuries will require radiographs and/or referral to an orthopedic surgeon. Appropriate early treatment of extremity injuries will protect the athlete from further harm and can hasten recovery. Return to play decisions must be made on an individual basis depending on the severity of the injury, the ability to minimize the risk of further injury, and the functional abilities of the injured athlete.

Compliance with Ethics Guidelines

Conflict of Interest Luke Bulthuis declares that he has no conflict of interest. Daniel R. Wascher reports Institutional Fellowship Support from Arthrex and from Smith & Nephew outside the submitted work.

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