Pediatric Fractures and Dislocations

Here's when to treat these open and when to treat these closed.

Goals and Objectives

After completing this CME:

1) The reader will understand the variety of pediatric foot fractures

2) The reader will understand the indications for closed and open treatments for pediatric foot fractures

3) The reader will understand the nature of the complications encountered in pediatric foot fractures

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*Following this article, an answer sheet and full set of instructions are provided (p. 186).—**Editor***

By Edwin Harris, D.P.M.

Fractures of the child's foot and ankle occur surprisingly frequently. The types of injuries are age-dependent and relate to the child's physical size, developmental age and activity levels. Infants and younger children have lighter body masses, shorter bony lever arms and engage in less strenuous physical activities. Older children and adolescents are physically larger and engage in sports and other activities that predispose them to more forceful injuries.

Infants and very young children are more likely to develop cancellous fractures of bone that are often referred to as "toddler fractures." Older children and pre-adolescents are more likely to have diaphyseal and articular injuries.

Growth Plate Injuries

Growth plate injuries can occur at any age, and can happen even before the secondary centers have begun to ossify. Infants and younger children have wide open physes which are more liable to separate through the epiphyseal plate (Salter-Harris I).

As children age, the physes become more mature and correspondingly thinner. These physiologic events predispose them to fractures that enter the growth plate and exit either through the metaphyseal bone or through the epiphysis and into the joint space (Salter-Harris II and III).

As growth plates become even more mature, trauma near articulations can fracture across the joint surface, epiphysis, physis and metaph-

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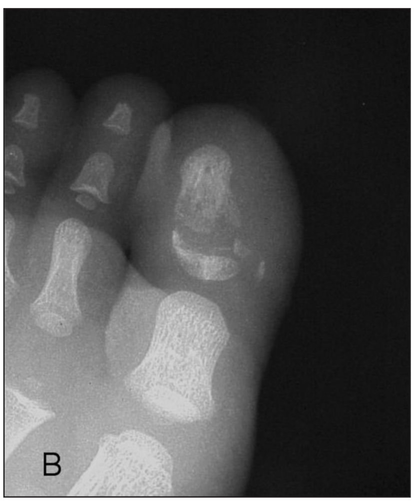
ysis (Salter-Harris IV). These injuries can displace the articular surface and cause partial epiphyseal arrest. The result is arthrosis and angular deformity.

Some injuries (at any age) can totally shut down the function of the physis and result in premature plate closure (Salter-Harris V).

Figure 1: A closed comminuted fracture. The skin is intact. The fracture does not communicate to the environment.



Closed Fractures

Closed (simple) fractures do not produce an open wound in the skin. (Figure 1) They are the most common pediatric foot fractures. They can be relatively innocuous, or may result in considerable soft tissue damage (complex fractures). Open fractures have a breech in the skin that leads to the bone injury and allows the fracture to communicate to the environment. (Figures 2A-C) This opening can be produced by penetrating trauma from the outside, or by a sharp segment of bone piercing the skin from within. Open pediatric foot and ankle fractures occur much less frequently than closed injuries.

Infants and very young children are more likely to develop cancellous fractures of bone.

Closed fractures are generally more benign and have fewer complications. Open fractures are at risk for infection. Damage to the soft tissues in both types of fractures may compromise the blood supply to the fracture fragments and surrounding soft tissues. Both types of fractures may have significant displacement.

Most closed fractures are easily manipulated back into alignment unless there is soft tissue interposition between the fracture fragments (Figure 3). This complication is more likely to occur in open fractures and it makes manipulative reduction difficult or impossible. Damage to the supporting soft tissue may make stabilization difficult in both open and closed fractures.

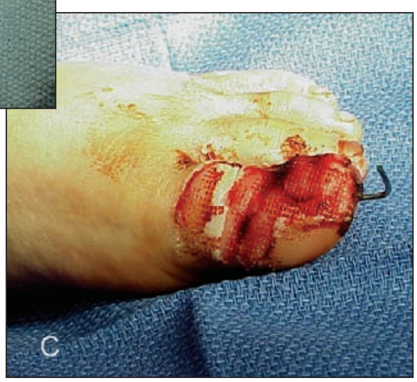


Figure 2A-C: A lawnmower accident in a two-year-old male produced a severe laceration of the hallux and the plantar of the foot (A). There is an open comminuted fracture of the distal phalanx with some bone loss (B). After appropriate irrigation of the wound, the unstable fracture was fixated with a Kirschner wire (C).

Open Fractures

Open fractures often have considerable skin and subcutaneous tissue loss that may leave an unstable fracture open to the environment and necessitate temporary external fixation. The fundamental rule is that closed fractures should remain closed whenever possible and open fractures require irrigation, debridement, stabilization, and eventual wound closure.

The majority of forefoot fractures in children are closed. Just about every fracture pattern has been reported. These include greenstick, transverse, spiral, oblique, intra-articular and burst patterns. Fractures may be single or multiple.

Most open fractures occur with injuries that produce both the fracture itself and some form of laceration. Most of these are simple and relatively easy to manage. Open rearfoot and ankle fractures, however, can damage the neurovascular structures, epiphyseal plates and joint surfaces. Some injuries may be limb-threatening.

Some open injuries may have a very tiny skin opening and appear to be very innocuous. This is particularly true of fractures that involve the distal phalanges and the nails (Figure 4). Burst fractures of the distal phalanges from falling objects and stubbing injuries lacerate the nail bed and produce a subungual hematoma.

The lacerated nail bed communicates directly to the fracture. The hematoma under the nail plate serves as a culture medium for bacteria and increases the risk of osteomyelitis. These injuries require debridement of the nail, irrigation and suturing of the nail bed. Stubbing trauma may fracture the distal phalanx through its physis.

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Figure 3: A hyperflexion injury of the hallux produced a fracture of the physis of the distal phalanx and a fracture of the dorsal portion of the base (arrow). Closed reduction was impossible because periosteum from the phalanx invaginated into the fracture. Open reduction became necessary.

Figure 4: A heavy object fell on the end of the second toe. The nail plate was traumatically avulsed. The distal phalanx is extensively comminuted. The nail bed was lacerated.

Although the fracture line is proximal to the eponychium, the nail plate often is avulsed and the nail root is lacerated. (Figure 5 A-B) This allows communication to the outside through the lacerated proximal nail fold to the fractured physis. Physeal arrest is another potential complication.

Management of Closed Fractures

Protection Alone

Some fractures are best managed by protection alone without reduction or the need for rigid immobilization. This amounts to treatment by benign neglect. In order for this to be indicated and successful, the fracture has to be stable and not displaced Figure 6A-B).

Most healing stress fractures are easily managed by this technique. By the time that they are recognized radiographically, they are about two weeks into the healing process. They are identified by periosteal new bone that develops adjacent to the fracture site (Figure 7A-B). Most of the time, the fracture line itself is not seen. If a fracture line is visualized, the probability is that a stress fracture has progressed to a pathological fracture (Figure 8).

In spite of this conversion, these fractures usually remain stable. The success of this type of fracture management depends on a number of factors. The location of the fracture is important, as are the physical size and activity of the patient. Patient age and cooperation must be factored into the decision to treat by this technique.

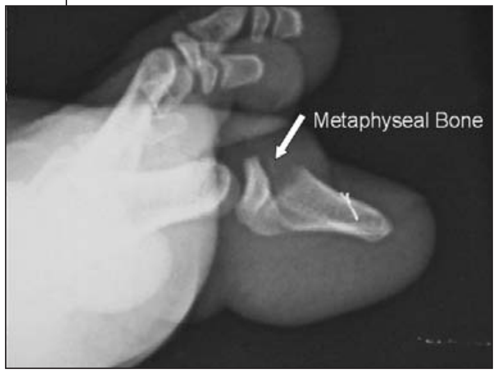

Figure 5: A hyperflexion injury of the hallux produced an open displaced Salter-Harris II fracture of the distal phalanx. The nail root was avulsed and the nail bed was lacerated at the lunula.

Cancellous fractures are common in toddlers. These occur in bones that have minimal cortical development around large amounts of cancellous bone. The cuboid and the calcaneus are the most common sites. (Figure 9A-B) The injury may or may not be witnessed. Frequently, limping or an antalgic gait pattern are the presenting complaints.

Like stress fractures, this injury is radiographically silent until new bone begins to form on damaged trabeculae about 10 to 14 days after the injury. Initial treatment is based on a high index of suspicion. By the time the fracture is recognized, the risk of displacement is minimal. Treatment is largely directed at comfort for the child.

Sometimes, the child does not present for diagnosis until a fracture is almost completely healed. At that time, the risk for additional injury is negligible. Most of these children don't need any treatment at all (Figure 10A-B).

Immobilization With or Without Weight-Bearing

Because of their nature, complexi-

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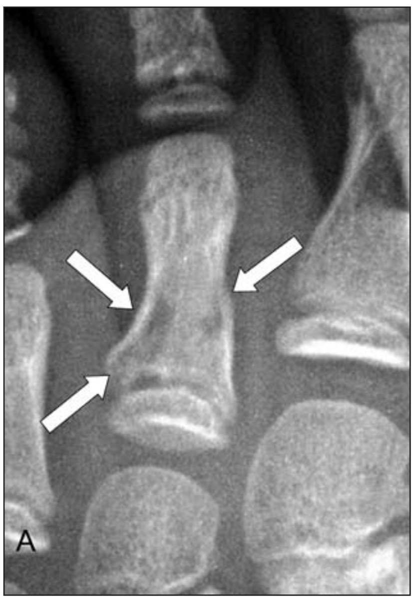

Figure 6A-B: (A) There is a stable diaphyseal fracture of the second proximal phalanx. It is well aligned, and is unlikely to displace. (B) There is a buckle (torus) fracture of the distal fifth metatarsal metaphysis. Although the cortex has failed, the fracture line itself is unlikely to progress.

ty and location, some fractures are inherently unstable or have the potential to become unstable. These include multiple fractures, comminuted fractures and fractures that may displace because of their location in the bone (Figure 11A-B.)

Comminuted fractures at the bases of the metatarsals are good examples of these types of injuries. Other fractures are unstable because they involve insertions of major tendons. Some intra-articular fractures may initially have congruent joint surfaces, but they are at risk for displacement. These include fractures of the first proximal phalanx (Figure 12).

Other fracture patterns are unstable and displaced, but the alignment is acceptable. Muscle pull and gravitational forces may cause angulation, rotation, or overriding of the fracture segments (Figure 13). Additional attempts at closed reduction would be unlikely to improve the position and might make management more complicated. Occasionally, an unstable, displaced but almost united fracture is encountered. These usually require simple protection alone.

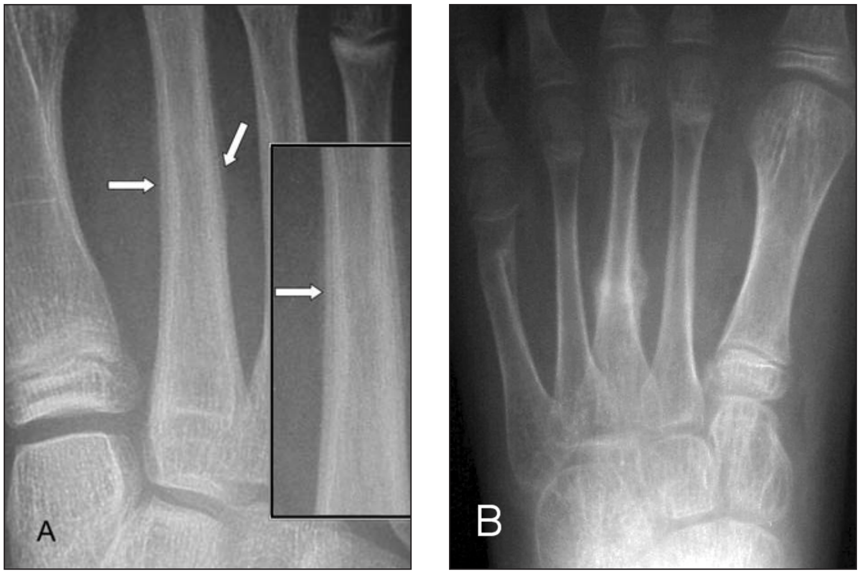

Figure 7A-B: (A) There is a stress fracture of the second metatarsal diaphysis. A cuff of periosteal new bone can be seen (white arrows). More detail can be seen in the inset. (B) More extensive periosteal new bone can be seen in this third metatarsal diaphyseal stress fracture.


Figure 8: This healing stress fracture shows an almost complete fracture line (black arrows)

Treatment

These fractures are initially managed with splints. Once edema has subsided, immobilization can be continued with casts. At this point, the decision to treat initially by non-weight-bearing or allow for immediate weight-bearing immobilization must be made. If early weight-bearing might produce excessive motion or allow displacement, treatment should begin by two to three weeks of non-weight-bearing. Past that point, most fractures are sufficiently consolidated so that they can safely tolerate bearing weight in a cast.

Under certain circumstances, walking boots may be substituted for casts. The ability to remove them is both an advantage and a disadvantage. In appropriately selected patients, a walking boot can be removed for bathing and sleeping. In non-compliant patients, there may be extreme difficulty keeping this apparatus on. Along the same lines, some metatarsal fractures can be managed with surgical shoes for selected patients.

Manual Closed Reduction

Whenever it is practical and safe, displaced fractures are better managed by closed reduction. Simple closed techniques can be employed any time reduction is required, reduction can be achieved, and reduction is maintainable (Figure 14A-B)

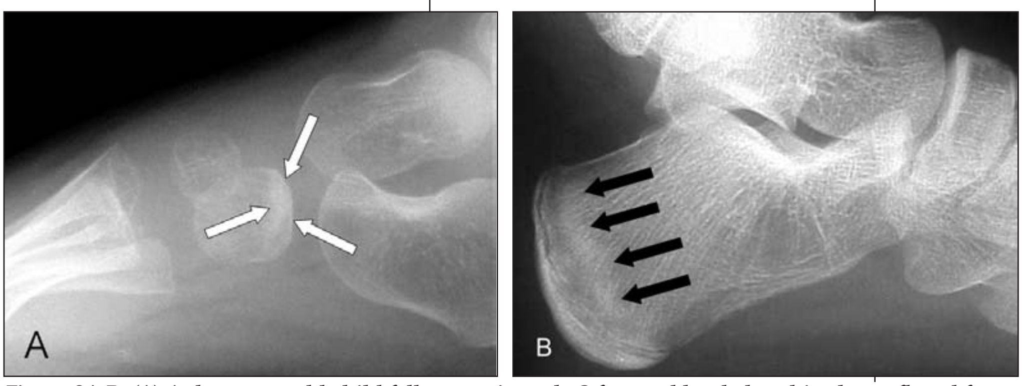

Figure 9A-B: (A) A three-year-old child fell approximately 3 feet and landed on his plantarflexed foot. There was edema, ecchymosis and pain localized over the dorsolateral tarsus. Initial radiographs were negative. Fourteen days later, sclerosis can be seen in the dorsal and proximal cuboid (new bone laid down on injured trabeculae). This cancellous fracture is sometimes referred to as a "toddler" fracture. (B) A 13 year old male had heel pain following heavy sports activities. Initial radiographs were negative. Two weeks later, a healing cancellous stress fracture can be seen in the calcaneal metaphysis (black arrows).

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Fractures...

As long as there is no vascular compromise, closed reduction can be safely performed under local anesthesia with or without sedation. The two most common reasons for failure of successful management are inability to achieve initial adequate reduction and subsequent loss of reduction (Figure 15A-B)

In some cases, successful reduction can be achieved by employing percutaneous Kirschner wires as "joysticks" to assist in the reduction, and then use them to maintain fixation (Figure 16).

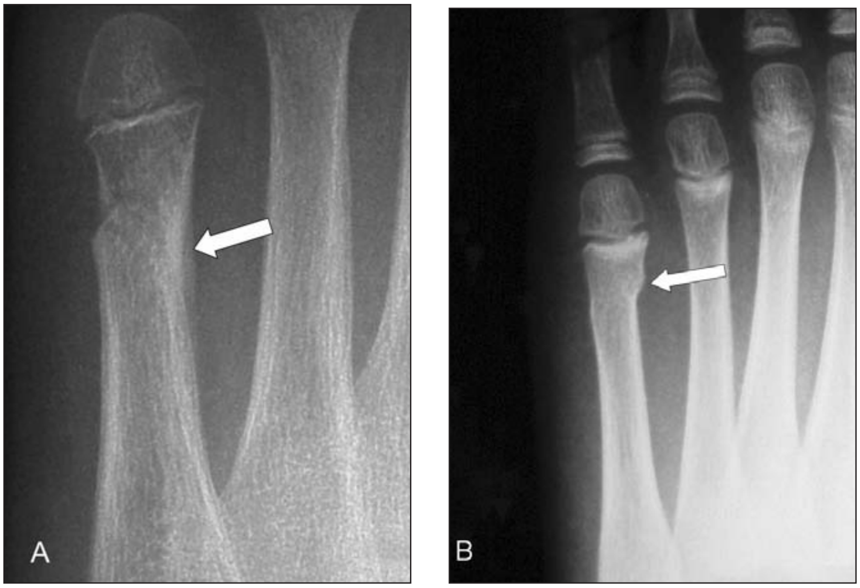

Figure 10A-B: Two fifth metatarsal neck fractures (white arrows). Both are almost completely healed at the time that these children presented for diagnosis. No protection is necessary.

Reduction by Traction

Reduction by traction as the principal treatment for fractures has all but been abandoned. In certain situations, traction provided by finger traps can be used to pull some fractures back out to length; however, these fractures are likely to be unstable. The result is almost immediate loss of alignment. Vascular complications and skin breakdown make closed reduction by continuous traction unattractive. An additional issue is the cost to cover the apparatus and nursing care needed for the comparatively long convalescence.

Immediate Fixation

In order to decrease morbidity and get patients back into function as quickly as possible, some fractures are best managed by immediate fixation. This can be accomplished through the use of external fixators, intramedullary fixation, percutaneous fixation and fixation with plates and screws.

Figure 12: Regardless of patient age, fractures involving the articular surfaces must be well aligned in order to prevent arthrosis. This comminuted fracture of the first proximal phalanx in a 12-year-old girl shows acceptable alignment. There is no step-off in the joint space, and the fracture line is less than 2 mm in width. Further reduction is not necessary.

Indications for external fixators include unstable oblique, spiral, and comminuted fractures. Additional considerations include skin loss, neurovascular compromise, bone loss and maintenance of length and stability in preparation for skin and bone grafting.

Indications for intramedullary fixation include unstable oblique, spiral, and minimally comminuted fractures. Best indication is for fractures that can be adequately and accurately reduced by closed means, but the nature of these fractures makes it unlikely that alignment can be maintained by simple immobilization alone.

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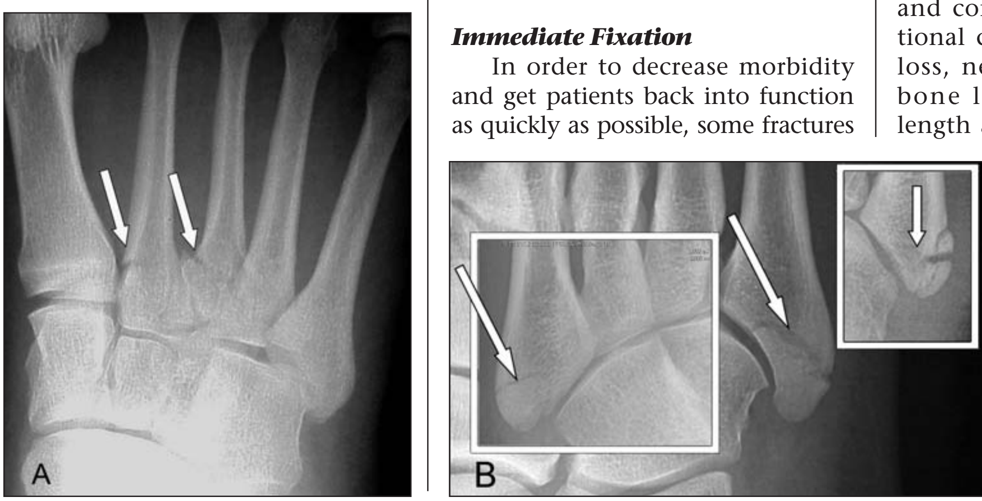

Figure 11A-B: (A) Multiple lesser metatarsal base fractures need protective immobilization. The long lever arms will allow movement at the fracture sites. (B) Fifth metatarsal base fractures in children may be comminuted and may extend into the joint space. Additionally, the traction apophysitis of the fifth metatarsal base is often involved. Although they have a very high union rate, they are better managed in active children by immobilization.

Fractures...

Intra-Articular Fractures

Intra-articular fractures must be reduced precisely anatomically or degenerative arthrosis will result. Major articular injuries require screw fixation to maintain joint surface congruity. Penetration of the growth plate must be avoided (Figure 17).

Avulsion Fractures

Avulsion fractures of the margins of the small joints of the feet lend themselves well to percutaneous or open fixation through the use of smooth or threaded Kirschner wires (Figure 18A-B).

Figure 13: The long-term effects of displaced fractures can be malalignment, osteonecrosis and non-union.

Comminuted Intra-Articular Fractures

Comminuted intra-articular fractures are particularly difficult to manage because they are very unstable and there are significant step-offs on the articular surfaces. The fracture margins need to be perfectly aligned in order to restore the anatomy of the articular surface (Figure 19A-B).

Displaced Fractures

Some fractures displace widely enough so that surrounding soft tissues (tendon, capsule, ligament of the soft tissues) can enter the fracture gap. They serve as mechanical impediments to reduction and make open reduction necessary. At the same time, fracture fixation can be accomplished by replanting and fixating the fracture fragments.

Some fractures are grossly unstable. Some form of reduction can be achieved, but it becomes impossible to maintain this reduction. This is particularly true for metatarsal fractures in the distal one third. Because of displacement and fragment rotation, it may be impossible to achieve a closed reduction. Rather than accept these misaligned fractures, treat these by open reduction and intramedullary fixation (Figure 20A-B).

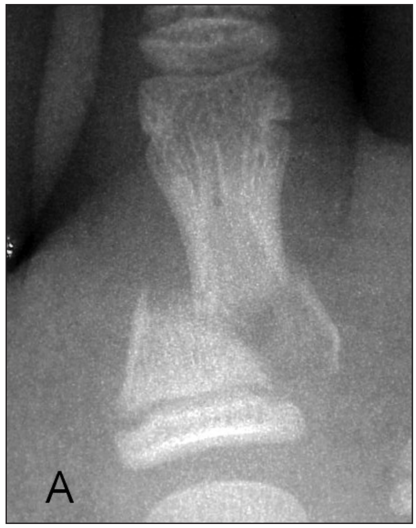

Figure 15A-B: (A) This second proximal phalanx fracture was initially manipulated into reduction. Reduction was completely lost. By the time it was recognized, it was too late to attempt further reduction. (B) Fortunately, there is considerable potential for remodeling in young children. During fracture healing, it remodeled to near normal (white arrows)

High-Risk Fractures

Only a very few pediatric foot fractures carry a high risk of non-union. Jones fractures are the best examples. These occur at the junction of the diaphysis and the base of the fifth metatarsal. They are more or less transverse, but they occur in an area of bone that is deficient in blood flow. Although a significant number of them will heal, the nonunion and refracture rates are quite high. They frequently occur in elitist athletes and can prove disastrous to their careers. Because of these high risks, primary fixation is justified (Figure 21A-B).

Open Fractures

By definition, any fracture that penetrates the skin is an open fracture. With this type of injury, there are a number of additional factors that must be considered. First, the skin is breeched. This creates an open wound, the size of which is determined by the na-

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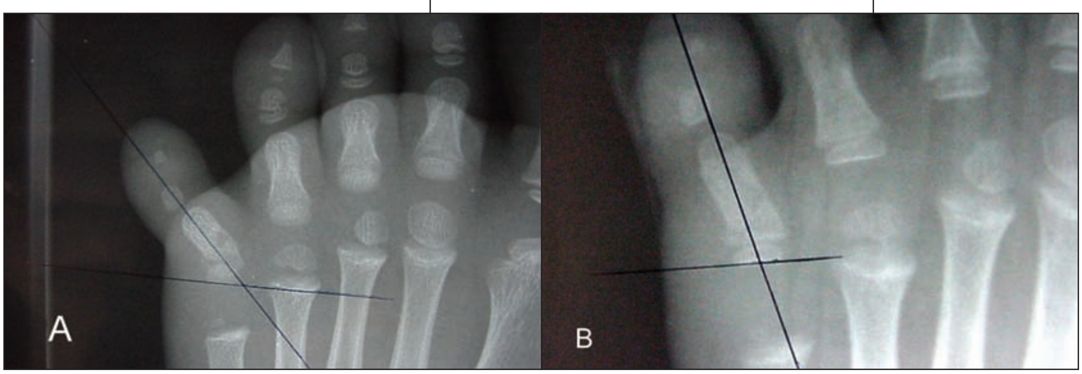

Figure 14A-B: (A) A 30 month old male stubbed his fifth toe. There is significant angular displacement of the fifth proximal phalanx. (B) Under local anesthesia, the fracture was successfully manipulated into better alignment.

Fractures...

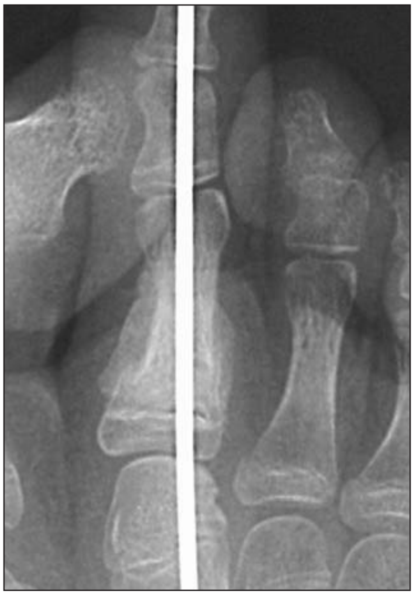

Figure 16: A 13 year old spastic diplegic fractured and completely displaced his second proximal phalanx. Attempted closed reduction failed, so the fracture was percutaneously fixated with a Kirschner wire.

ture of the injury. Significant tissue loss makes management of the fracture very difficult.

Not only is it necessary to stabilize the fracture so that it heals in the best anatomic position, but skin loss necessitates preparation of a viable bed for subsequent split or full thickness skin grafting. Second, the risk of osteomyelitis is quite high. Third, open fractures are often complicated by loss of bone. This requires grafting a bone in order to restore length, alignment and stability.

Figure 17: This complex triplane fracture of the distal tibia involves the articular surface as well as the metaphysis. It is necessary to anatomically align and fixate the articular surface under direct vision.

Penetrating Trauma

Since the foot is a weight-bearing organ, sharp and blunt objects may penetrate the skin with considerable force. They may go to the bone and produce comminuted fractures or bone can be gouged away (Figure 22A-B).

Gunshot wounds to the foot are also very common. Bone and soft tissue damage depend on the size of the projectile and the proximity of the victim to the muzzle of the gun. In most cases, considerable soft tissue damage also occurs. Compartment pressures may be elevated enough to warrant fasciotomy. Multiple fractures are the rule. Fractures are usually comminuted, and alignment of the fracture fragments is difficult to achieve and maintain (Figure 23).

Fractures may also occur in asso-

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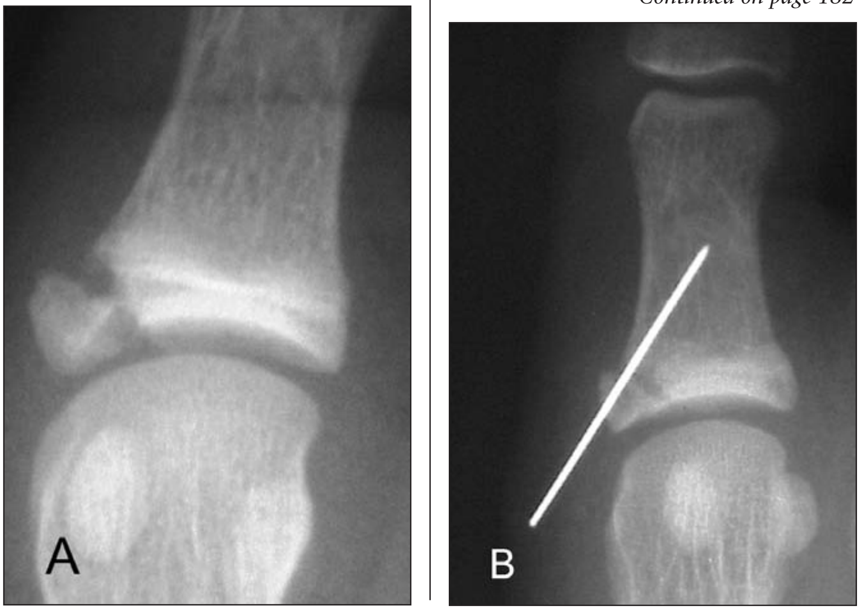

Figure 18A-B: Pull-off fractures of the articular margins of short tubular bones can involve a significant portion of the articular surface (A). These may be fixated with smooth or threaded Kirschner wires (B).

Figure 19A-B: (A) An extensively comminuted fracture of the first proximal phalanx shows significant articular surface displacement. This fracture was reduced under direct vision, the articular surface was restored and the fracture was fixated with Kirschner wires (B).

Fractures...

ciation with major lacerations. These usually come from lawnmower injuries, marine propeller injuries and farming accidents. The wounds are usually grossly contaminated.

Fractures may become open when a segment of bone pierces the skin from within. A similar thing may happen when violent dislocation occurs (Figure 24A-B.)

The wounds associated with open fractures require special management to remove contamination, debride necrotic tissue, and prepare them for closure with or without surgical intervention. Improper management will result in soft tissue infection, osteomyelitis, vascular compromise, and even loss of the limb.

Dislocations

Dislocations may occur with or without a fracture and may be open or closed (Figure 25A-B). Successful reduction can only occur when there is no soft tissue interposition to prevent joint realignment. Tendon, capsule, and ligaments are the tissues that usually prevent reduction. On occasion, nerve and blood vessel may be trapped in the dislocation.

Dislocations may be subtle. Failure to recognize the dislocation and promptly reduce it often results in long-term arthrosis and suboptimal function.

Complications

Avascular Necrosis

Both open and closed management of fractures may result in predictable complications. Avascular necrosis of the epiphyses in growing children can occur if they are damaged either by the trauma of the fracture or resulting edema (Figure 26). This may result in joint collapse. Growth arrest may result from epiphyseal avascular necrosis or from direct damage to the physes when they are involved in the fracture (Figure 27). Arthrosis may occur when joint sub-

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Figure 20A-B: (A) A fall from a height produced stable fractures of the second and third metatarsals and a completely displaced distal fourth metatarsal fracture. An attempt was made to reduce this in the emergency room, but 24 hours later the fourth metatarsal was unreduced. Radiographs on several other planes showed a very wide separation of the fracture fragments that could only be appreciated on the oblique projections. (B) Open reduction and Kirschner wire fixation stabilized the fracture.

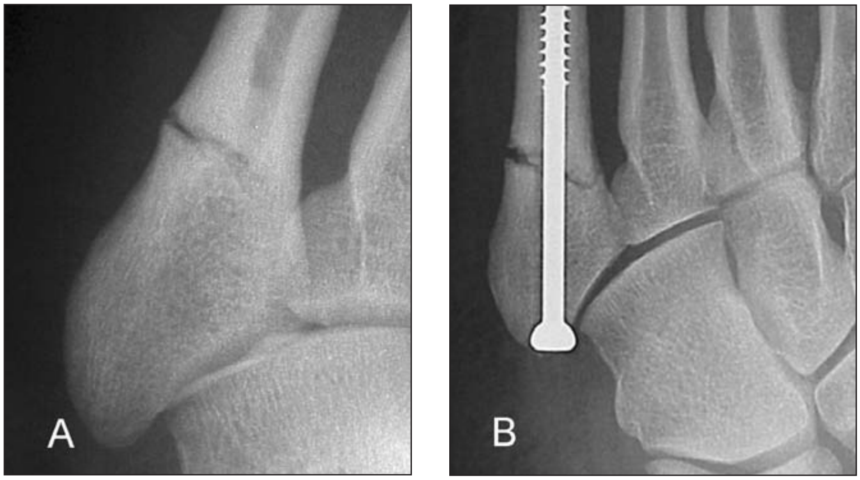
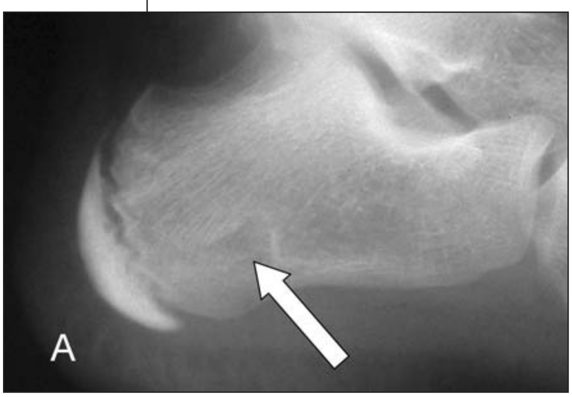


Figure 21A-B: (A) Jones fractures of the fifth metatarsal base have a high nonunion rate. Screw fixation stabilizes the fracture and produces compression across the fracture line (B).



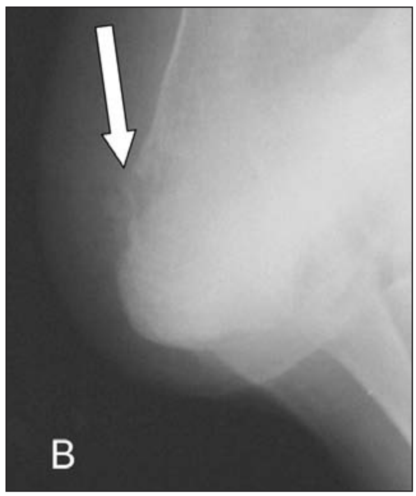


Figure 22A-B: An 11 year old male jumped from a swing and impaled his heel on the threads of a large screw. This foreign body penetrated bone and gouged out several small fragments from the calcaneus.

Fractures...

Figure 23: Gunshot wounds result in multiple fractures, considerable soft tissue damage with the potential for increased compartment pressure and residual fragments of the projectile. The fractures tend to be extensively comminuted and difficult to stabilize.

luxations and dislocations are not recognized and treated (Figure 28). Arthrosis can also result from step-off injuries to the articular surface itself.

Mal-alignment

Mal-alignment is always a risk. Even if the fracture is explored in the operating room and reduced under direct vision, instability can result in shortening or angular deformity (Figure 29). Unlike adults, the remodeling potential for children is much higher. Fractures close to the epiphyses, with deformation in the plane of joint motion, are likely to remodel almost completely and leave little functional deformity. Fractures at right angles to joint motion do not have much potential for spontaneous remodeling. Therefore, it is necessary to secure and maintain good anatomical alignment.

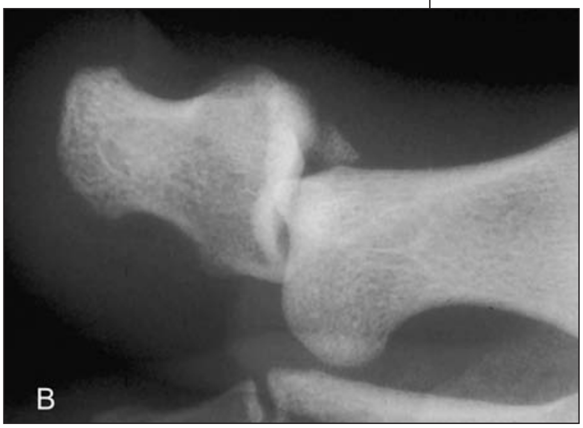


Figure 25A-B: (A) A close irreducible fifth metatarsophalangeal joint dislocation required open reduction to restore position of the plantar plate and long flexor tendon that were preventing reduction. (B) An open hallux interphalangeal joint dislocation resulted in a jagged laceration of the plantar and medial skin. The dislocation was irreducible and required open reduction and Kirschner wire fixation.

Conclusions

There are a number of practical points to be made. Fractures are better managed closed whenever possible. Risk of infection is reduced almost to zero. Vascular supply to the fracture fragments is preserved. As long as surrounding soft tissues don't block fracture reduction, they tend to support the fracture fragments and maintain alignment.

Open fractures have their own inherent risks of infection and vascular damage. They have to be managed as such with attention given to preparing the wound by irrigation, debridement, and stabilization of the bone in anatomical alignment.

Some fractures are open by their very nature, but the breech in the skin is very subtle. Comminutions of the phalanges with subungual hematomas are always open fractures. Epiphyseal plate injuries of the distal phalanges of the toes are usually open fractures. Soft tissue in the resulting defect in the physis may prevent realignment and jeopardize healing.

Percutaneous fixation (if possible) is preferable to open reduction. In order for this to be successful, the surgeon must have the skill to perform this type of procedure, and must have imaging modalities readily available.

Open reduction is indicated if satisfactory alignment cannot be achieved, the fracture is irreducible because of soft tissue interposition, the fracture is unstable, or the nature and the natural history of the fracture warrant it.

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Figure 24A-B: A fracture in the distal second metatarsal resulted in a portion of the distal fragment that rotated dorsally and penetrated the skin (A and B)

Fractures...

Open reduction is indicated to facilitate faster healing, easier rehabilitation and earlier mobilization. ■

Recommended Readings

Ashworth A, Hedden D, 1994. Fractures of the Ankle. In: Management of Pediatric Fractures (Letts RM, ed.). New York: Churchill Livingstone; 713-734.

Baxter MP, 1994. Fractures and Dislocations of the Metatarsals and Phalanges of the Foot. In: Management of Pediatric Fractures (Letts RM, ed.). New York: Churchill Livingstone; 767-788.

Bordelon R, 1993. Fractures of the child's foot. In: Pediatric Fractures: A practical approach to assessment and treatment (MacEwen CD, Kasser JR, Heinrich SD, eds.). Baltimore: Williams and Wilkins; 343-365.

Figure 26: A Salter I second metatarsal fracture was diagnosed in an eight-year-old girl following trauma. Two months later, there is sclerosis of the second metatarsal head and some minimal collapse. This avascular necrosis is reminiscent of Freiberg's infraction.

Figure 27: Fractures across the growth plate can result in partial or complete growth arrest. This child sustained a Salter IV fracture of the third metatarsal (white arrows). The physis subsequently closed prematurely and resulted in significant disturbance of the metatarsal parabola (inset, open black arrow).

> ***Intra-articular fractures must be reduced precisely anatomically or degenerative arthrosis will result..***

Carrol N, 1994. Fracture and Dislocation of the Tarsal Bones. In: Management of Pediatric Fractures (Letts RM, ed.). New York: Churchill Livingstone; 751-766.

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Figure 28: Long-standing dislocations may result in permanent arthrosis.

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EXAMINATION

See answer sheet on page 187.

1) The most common fracture pattern in the infant and young child is:
A) fracture of the epiphysis
B) fracture through the growth plate
C) fracture in cancellous bone
D) fracture into the joint space

2) The most important determiner for the pattern of growth plate fractures is:
A) the mechanism of injury
B) the weight of the child
C) the gender of the child
D) the maturity of the growth plate

3) The most common cause for failure of closed reduction in pediatric fractures is:
A) comminution of the fracture ends
B) uncontrolled edema
C) soft tissue interposed between the fracture fragments
D) intact periosteum

4) Burst fractures of the distal phalanges with subungual hematomas and disrupted nail beds must be regarded as
A) open fractures
B) grossly necrotic bone
C) grossly unstable fractures
D) benign with no special treatment indicated

5) Which of the following fractures best meets the criteria for management by simple protection?
A) fractures that require open reduction
B) fractures that require closed reduction
C) fractures less than 24 hours old
D) fractures that are almost healed

6) Cancellous fractures of the calcaneus and cuboid in infants and toddlers are treated by immobilization in order to:
A) prevent displacement
B) provide pain relief for the child
C) provide stability for potentially unstable fractures
D) prevent conversion to pathological fracture

7) Stress fractures and cancellous fractures may be radiographically invisible until:
A) one to two days after the trauma
B) ten to 14 days after the trauma
C) three to four weeks after the trauma
D) may never visualize

8) Which of the following fractures does not require immobilization?
A) an oblique fracture of the fifth metatarsal shaft that is almost healed
B) a fracture of the first proximal phalanx
C) multiple metatarsal base fractures
D) successfully closed reduced, but unstable fractures

9) Fractures associated with significant edema are best managed initially by:
A) immediate casting
B) splints
C) ice and dependent positioning
D) Ace bandages

10) Which of the following fractures is best managed in a nonweightbearing cast?
A) a fracture of the fifth metatarsal tuberosity
B) a cancellous fracture of the cuboid
C) a fracture of the distal first metatarsal
D) a fracture of the second, third and fourth proximal phalanges

11) Complications resulting from managing fractures by traction techniques include all of the following except:
A) vascular compromise
B) skin breakdown
C) prolonged immobilization time
D) premature growth plate closure

12) Fractures that can be adequately and accurately reduced by closed means, but are unlikely to maintain alignment are best managed by:
A) casting off-weight-bearing
B) internal fixation with Kirschner wires, screws or plates
C) splints or a Jones dressing until edema subsides
D) immediate bone grafting

13) Which of the following is not an indication for application of an external fixator for a fracture?
A) fracture with skin loss
B) fracture with bone loss
C) neurovascular compromise
D) closed, but mal-aligned fracture

14) The long term complication of mal-united intra-articular fractures is:
A) joint instability
B) angular deformity
C) arthrosis
D) avascular necrosis

Continued on page 186

Continuing Medical Education

EXAMINATION

(cont'd)

15) Which of the following pediatric fractures is most likely to result in nonunion?
- A) fracture of the distal third of the metatarsal
- B) Jones fracture of the fifth metatarsal
- C) calcaneal stress fracture
- D) oblique fracture of the fifth proximal phalanx

16) A significant risk in Jones fractures of the fifth metatarsal is:
- A) mal-alignment
- B) infection
- C) avascular necrosis
- D) re-fracture

17) The initial step in the management of open fractures is:
- A) Early primary closure of the wound
- B) Radical debridement of the margins of the wound
- C) Removal of all loose bone fragments
- D) Irrigation of the wound and removal of all gross contamination

18) Mal-aligned fractures close to the functioning growth plates in children are likely to remodel as long as:
- A) the mal-alignment is under 5°
- B) the mal-alignment is at right angles to the plane of joint motion
- C) the mal-alignment is in the plane of joint motion
- D) the mal-alignment has a rotatory component

19) The initial treatment for fractures and dislocations that cannot be reduced is:
- A) external fixation
- B) casting until the edema subsides
- C) repeat attempt at closed reduction until successful
- D) surgical exploration to remove the impediment to reduction

20) Which of the following is not an indication for open or percutaneous reduction of foot fractures?
- A) the fracture is irreducible
- B) closed reduction cannot be achieved
- C) minor mal-alignment remains after closed reduction
- D) when faster healing and convalescence become critical issues

See answer sheet on page 187.

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Pediatric Fractures and Dislocations (Harris)

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5.	A	B	C	D	15.	A	B	C	D
6.	A	B	C	D	16.	A	B	C	D
7.	A	B	C	D	17.	A	B	C	D
8.	A	B	C	D	18.	A	B	C	D
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