ANKLE FRACTURES IN CHILDREN

Computed tomography is useful for preoperative planning and post-reduction assessment for intra-articular pediatric ankle fractures.

Nondisplaced pediatric ankle fractures can be effectively managed with cast immobilization and close radiographic follow-up evaluation.

Physeal ankle injuries in younger children with considerable growth remaining should be followed closely for at least one year after injury as growth arrest may result in substantial angular deformity.

Open reduction and internal fixation should be strongly considered when an articular step-off of <2 mm cannot be maintained by closed means for Salter-Harris type-III and IV and transitional ankle fractures.

Ankle fractures in children are the third most common fracture involving the growth plate after finger and distal radial physeal fractures.

Epidemiology

10% physeal injuries
The ankle is a hinge-type joint
Distal tibial ossification center appears at 1 year and fuses at 15 years in girls and 17 years in boys.
The distal tibial physis closes during an eighteen-month period centrally, then medially, and finally laterally.
Growth in the distal tibial physis contributes 40% of tibial length or approximately 3 to 4 mm/yr.
There is minimal longitudinal growth from the distal end of the tibia after the age of 12 years in girls and 14 years in boys
The distal fibular ossification center appears at 2 years and fuses at 17 to 19 years.

The os subtibiale is an accessory ossification center of the medial malleolus present in 0.9% to 20%
and the os subfibulareis present in 2.1%.

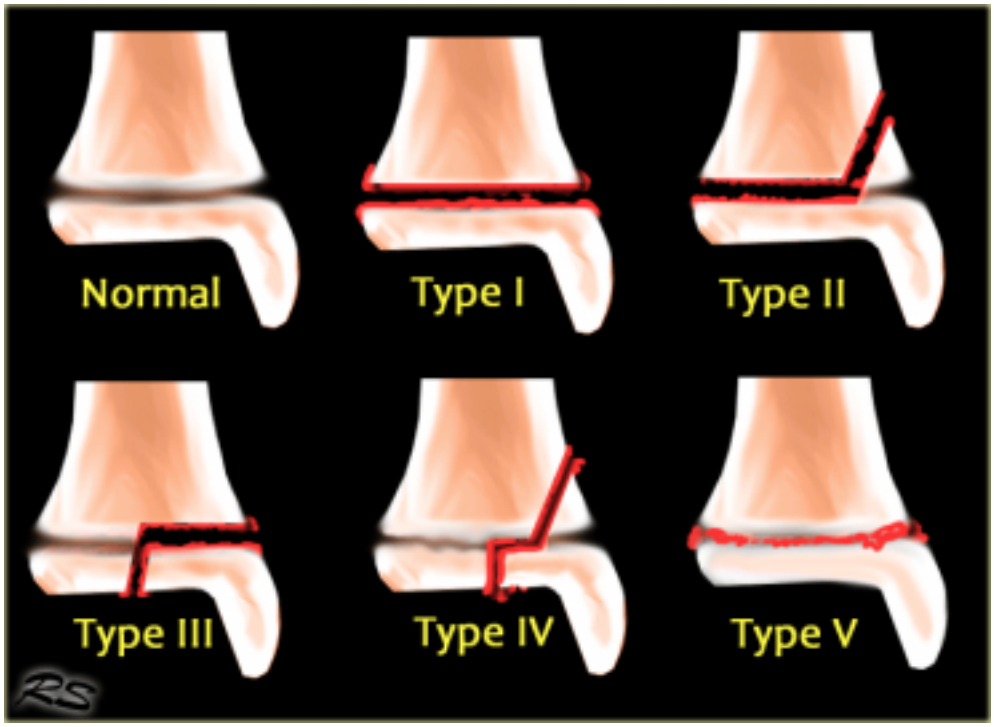
Imaging

1. Anteroposterior, mortise, and lateral radiographs
2. CT scans: CT scans are more sensitive at detecting fractures displaced >2 mm.

3. The role of MRI remains unclear, but it may be useful to identify occult fractures, assess for
premature physeal closure, or identify sources of persistent pain after fractures have healed.

Classification

Salter-Harris classification



Triplane ankle fractures are transitional fractures that occur toward the end of growth and are not easily classifiable with the Salter-Harris. The classic triplane fracture consists of three parts: a rectangular fragment of distal tibial epiphysis, a large fragment that includes the remainder of the epiphysis with a metaphyseal spike, and the tibial shaft.

The juvenile Tillaux fracture is also a transitional fracture. The anterolateral distal tibial physis is the last portion of the distal tibial growth plate to close, and the anterior inferior tibiofibular ligament produces an avulsion of an epiphyseal fragment during an external rotational injury.

Treatment

The decision to treat pediatric ankle fractures is based on the fracture type, amount of displacement, and the ability to restore and maintain the alignment of the physis and the congruity of the ankle joint. If a satisfactory closed reduction can be achieved and maintained, internal fixation is unnecessary; however, if closed reduction is unsuccessful, open reduction with or without skeletal fixation is warranted.

Type VI, a physeal loss from open fracture, was not part of the original Salter-Harris classification system.

Salter-Harris Type-I

15%

Rarely severely displaced without a concomitant fibular fracture.

We recommend immobilization in a below-the-knee cast

Displaced Salter-Harris type-I fractures should have closed reduction with immobilization in a below-the-knee cast. Radiographic follow-up is recommended in the first week following injury to ensure that there is no recurrent displacement.

Distal Tibial Salter-Harris Type-II Fractures

38%

A nondisplaced Salter-Harris type-II distal tibial fracture may be immobilized in a short or long leg cast for three to four weeks, followed by weight-bearing in a cast

After 12 years with type-II fractures were unable to remodel angular abnormalities >5°. The inability to anatomically reduce Salter-Harris type-I and II distal tibial fractures is often caused by interposed soft tissue, particularly the periosteum.

In Salter-Harris type-I and II distal tibial fractures, noted that premature physeal closure occurred in 60% (twelve) of twenty fractures with >3 mm of physeal widening after closed reduction and in 17% (four) of twenty-four fractures with <3 mm of physeal widening after reduction.

Premature physeal closure in 25% in type-II fractures. They noted no premature physeal closure with Salter-Harris type-I fractures. The rate of premature physeal closure in fractures displaced >2 to 3 mm is as high as 60% and warrants consideration for open treatment to remove interposed soft

tissue.

Distal Tibial Salter-Harris Type-III and IV Fractures

Type-III and IV distal tibial fractures are problematic as both articular incongruity and premature physeal closure must be considered.

Type-III and IV fractures result from supination inversion injuries, which are similar to Lauge-Hansen supination adduction injuries in adults.

Schurz et al. reported that the adduction mechanism of injury causing Salter-Harris type-III and IV injuries caused greater physeal damage than the abduction and distraction forces that result in type-II.

Nonoperative treatment is reserved for nondisplaced fractures. A short leg cast is recommended, and careful radiographic surveillance.

There is consensus that displaced Salter-Harris type-III and IV fractures should be treated with open reduction and internal fixation. Salter and Harris recommended ‘‘accurate’’ and ‘‘perfect’’ reductions for type-III and IV fractures.

The commonly accepted ‘‘2-mm rule’’ is not based on clinical or experimental evidence.

Salter-Harris Type-V Fractures

These injuries involve axial or shear loading that damages the proliferative zone of the physis. May contribute to the high rate of growth disturbance associated with type-III and IV fractures.

Salter-Harris Type-VI

Lawnmower injuries account for many pediatric open ankle fractures and may cause Salter-Harris type-VI fractures.

Loder : They concluded that children who are less than fourteen years old should not operate power lawnmowers.

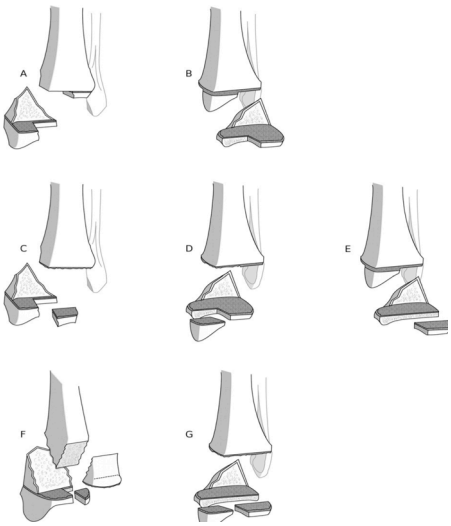
Treatment of these injuries with vacuum-assisted closure devices has shown a trend to reduce the number of free flaps and revision amputations needed for these injuries compared with traditional dressing changes.

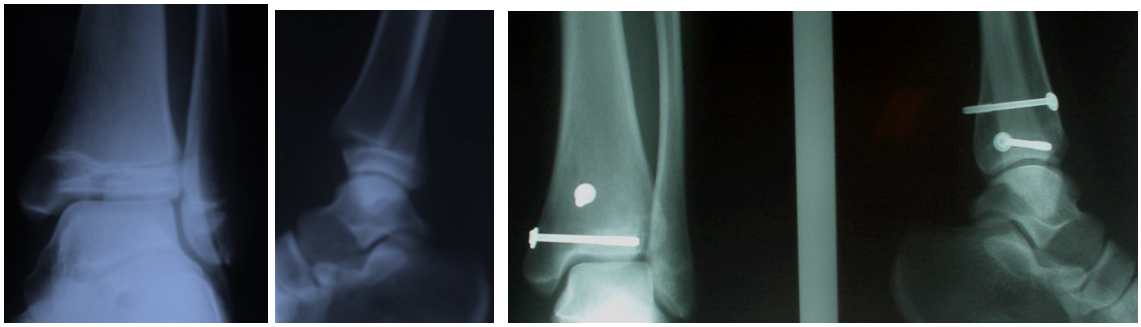
Triplane Fractures

6.3%

Minimally displaced and extra-articular triplane fractures may be treated with reduction and long leg immobilization. Difficulty in reducing fractures with >3 mm of initial displacement, and recommended open reduction and internal fixation for fractures with >3 mm of initial displacement or >2 mm of residual intra-articular step-off.

Recommended postreduction CT if the surgeon is unsure of the articular reduction, as long-term





outcomes seem to be improved with a more accurately reduced articular surface

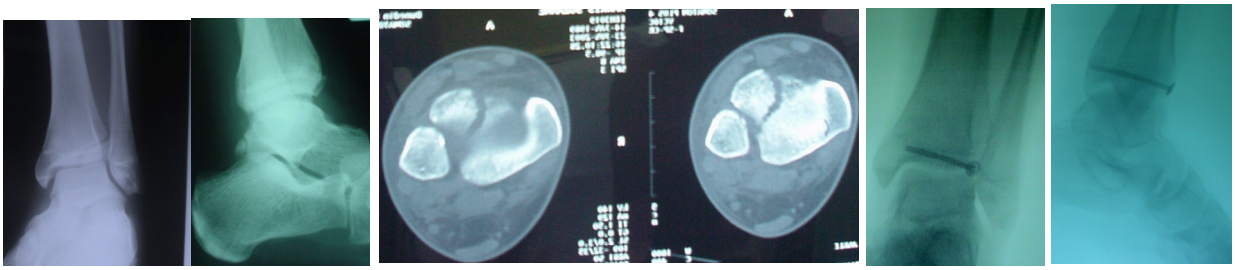
Juvenile Tillaux Fracture

The Tillaux fracture occurs in adolescents nearing the end of distal tibial physeal closure.

2.5%

Reduction is usually achieved with internal rotation.

For fractures with >2 mm of residual displacement measured by CT scan following an attempted closed reduction, anterior capsular interposition



should be considered. ORIF through Anterolateral approach; removal of the capsule and a single screw parallel to the physis is usually sufficient. fixation.

Fibular Fractures

Distal fibular fractures may occur in isolation or in association with distal tibial fractures.

Displaced fractures with associated distal tibial fractures are usually reduced and stable once the tibia is realigned. If the fibula remains unstable, then Kirschner wire fixation may be used. If the patient is nearing skeletal maturity, traditional treatment with a plate is appropriate. Syndesmotic screws are not commonly required for physeal ankle fractures as the distal syndesmotic ligaments are typically intact.

Metallic and Bioabsorbable Fixation

Internal fixation implants for ankle fractures in children are Kirschner wires or small-fragment metallic screws. Transepiphyseal screw fixation increases

the force and contact pressures across the tibiotalar joint compared with controls in adult and pediatric cadaver model. These forces return to prefixation levels when the screws are removed, suggesting that removal of fixation might be beneficial in children.