Management of ankle fractures in children

ABSTRACT

Ankle fractures are a common injury in children and adolescents – 1 in 1000 children will sustain an ankle fracture each year. Understanding the diagnosis and management of these injuries is vital for any doctor or clinician working in the emergency department, orthopaedics or providing community care. This review identifies the important features of high- and low-risk ankle fractures, how to prevent the use of unnecessary radiation and the management of these injuries. Fractures may be at high or low risk of instability and are managed accordingly. Many can be treated with conservative management in a cast, including unstable injuries following reduction. However, particular fracture patterns associated with the tibial growth plate need careful assessment of fracture reduction with cross-sectional imaging before committing to conservative management.

Ankle fractures are one of the most common group of injuries sustained by children. With an annual incidence of 1 in 1000, 4–5% of all fractures in children are of the ankle (Landin and Danielsson, 1983; Lyons et al, 1999; Voth et al, 2017).

There are some similarities between the assessment of ankle fractures in children and adults. The treatment of choice depends on the stability of the ankle joint. However, unlike adults, a child's ankle also has a growth plate which fuses during adolescence. Fractures through this growth plate can generate some unusual fracture patterns or cause occult fractures.

Diagnosis

As ankle injuries are so common, attempts have been made to develop clinical decision-making tools which can be used to screen potential injuries before X-rays are taken. The Ottawa ankle tool (*Table 1*) is widely used in adults to reduce the number of X-rays taken. The Ottawa ankle tool was developed in 1992 to reduce the burden of ankle X-rays performed in the emergency department, reducing radiation, cost and the need to transfer patients from remote areas (Stiell et al, 1992). The tool was developed using adults with simple, blunt injuries to their ankles.

In children the sensitivity of the Ottawa ankle tool is 97.9% (94.9–99.1) and specificity is 21.0% (13.1–31.9) (Beckenkamp et al, 2017). This means that for 100 children with ankles which are not fractured 89 'unnecessary' normal X-rays will be obtained. The sensitivity is lower than the near 100% demonstrated in adults (Bachmann et al, 2003). As a missed injury to the growth plate can be disastrous, a lower threshold for X-ray is required than for adults. Clinical judgement should be applied if the child has a high energy mechanism of injury.

An alternative tool, the low-risk ankle tool, was developed in Toronto for use in children to improve the specificity of the Ottawa ankle rules. This defines low-risk injuries as those with pain distal to the joint line of the ankle or in the anterior and posterior talofibular and calcaneofibular ligaments. The sensitivity of the low-risk tool is 100% (95% confidence interval 99.2–100) and specificity 67.8% (95% confidence interval 63.8–71.6) (Boutis et al, 2001).

High-risk ankle fractures

Broadly speaking, high-risk ankle fractures include displaced fractures of the fibular and growth plate injuries around the ankle. Isolated fractures of the fibular shaft are uncommon and often have a stable ankle joint. These can be treated in plaster.

Table 1. Ottawa and low-risk ankle tools

Ottawa ankle rules (Stiell et al, 1992)	Ankle X-ray required if	Pain at posterior edge of lateral malleolus
		Pain at posterior edge of medial malleolus
		Inability to take four steps in emergency department or immediately after injury
Low-risk ankle tool (Boutis et al, 2001)	No ankle X-ray required if	Pain is on the lateral side and distal to the ankle joint or if the pain is isolated to the lateral ankle ligaments

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Growth plate injuries

Growth plate injuries are classified using the Salter–Harris classification (Salter and Harris, 1963). This grading system identifies which regions of the growth plate are involved. The higher the score, the more likely that damage has occurred to the growth plate. In this situation, growth arrest or disturbance can occur. This has to be monitored in clinic with regular X-rays until normal growth can be confirmed.

Salter–Harris II: fracture through the growth plate and exiting through the metaphysis

Salter–Harris II fractures are the most common growth plate injury at the ankle, contributing to 32–40% of fractures (Speigel et al, 1978). If the fracture is through the fibular side and undisplaced then these can be treated as a low-risk fracture. However, if the fracture is displaced or through the tibial growth plate then these fractures require reduction and immobilization in cast. This can be done with procedural sedation in the emergency department, or with an anaesthetic in theatre. Some surgeons will increase the stability of the fracture using K-wires and this may be necessary with a very unstable injury.

Salter–Harris III: fracture through the growth plate and exiting through the epiphysis

In the adolescent ankle (12–15 years), a variant of a Salter–Harris III fracture can occur where the anterolateral distal tibia is avulsed at the insertion of the anterior tibio-fibular ligament. This is called a Tillaux fracture. This fracture pattern is a result of the relative weakness at this point in the ankle as the last area for the growth plate to fuse. Reduction of these fractures can be attempted as a closed procedure by plantarflexing the ankle, internally rotating and applying direct pressure to the fracture. A computed tomography scan is often helpful following reduction to confirm the manoeuvre has been successful, and to plan surgical reduction and fixation if required (Nenopoulos et al, 2015).

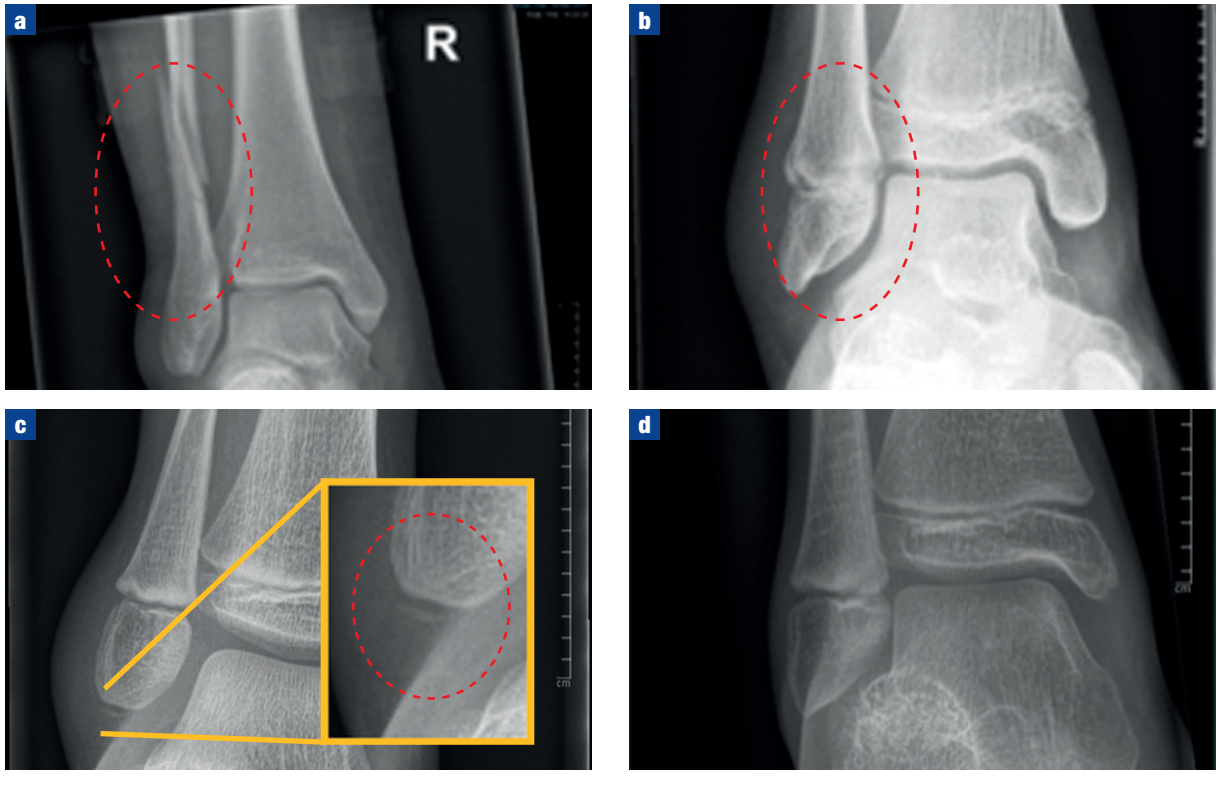
Salter–Harris IV: fracture extending through the growth plate and exiting through the epiphysis and metaphysis

Fractures to the ankle where the growth plate has only begun to fuse result in complex fractures called triplane fractures. This is caused by the unusual closure of the growth plate, from the middle of the plate to the medial growth plate then lateral. These fracture through the metaphysis and epiphysis in different planes. These injuries often involve the joint, and lead to poor outcomes if there is an articular step of more than 2 mm (Nenopoulos et al, 2015). Results from conservative management of these fractures are good (Zhang et al, 2018), but most surgeons will obtain a computed tomography scan to confirm anatomical reduction before committing to treatment in cast.

Low-risk ankle fractures

Low-risk fractures include a range of more common injuries including ligament injuries, Salter–Harris I fractures of the fibular growth plate (purely through the growth plate), avulsion fractures of the talus and distal fibula, and undisplaced fibular fractures (*Figure 1*).

Figure 1. Types of fibula fracture. **a.** High-risk fibula fracture. **b.** Low-risk undisplaced growth plate fracture. **c.** Low-risk fibula tip avulsion. **d.** Low-risk occult fracture (normal X-ray).



There is some debate as to the ideal management of these fractures. Most are stable and will heal with no intervention. Several studies (Boutis et al, 2010, 2016; Hofsli et al, 2016) have shown that many suspected Salter–Harris I fractures are in fact pure soft tissue injuries, and need no formal treatment at all.

However, many doctors will offer some form of immobilization for these injuries. In a Cochrane review, Yeung et al (2016) identified three randomized trials that looked at different immobilization strategies for these injuries. Boutis et al (2007) demonstrated that 80% of patients treated with a removable brace make a normal return to function at 6 weeks compared to 60% of children treated in a plaster cast (P=0.04) with a correspondingly higher functional score on the Activity Scale for Kids (91 *vs* 85, P<0.001). Barnett et al (2012) and Gleeson et al (1996) found a quicker return to normal activity when a brace or bandage was prescribed compared to a fibreglass splint or plaster for 6–8 days.

Although many children prefer to be placed in a cast for perceived greater protection and visibility at school (to prevent knocks), it seems that recovery is more rapid when a brace or supportive bandage is offered. Further work is required to definitively establish the best treatment for these injuries.

Other important considerations

When assessing these children, consideration should be given to identifying any additional injuries, assessment of neurovascular injury and the presence of any open fractures. In the presence of an open injury, more stable skeletal fixation is usually required – in a series of 25 distal tibial open fractures, authors from Birmingham Children's Hospital treated 21 children with internal fixation, K-wires or external fixation compared to just four treated with manipulation and casting (Nandra et al, 2017).

Conclusions

Ankle fractures in children and should be categorised into high risk – requiring proactive treatment with cast or surgery – and low risk – requiring supportive treatment to encourage recovery. The nature of the distal tibial growth plate can generate some unusual fracture patterns which should be screened for carefully when analysing ankle X-rays from adolescent children. **BJHM**

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KEY POINTS

- Ankle fractures are very common in children.
- Use an evidence-based tool to identify which ankles need X-rays and reduce unnecessary radiation exposure.
- Triplane and Tillaux fractures are injuries that occur when the growth plate is fusing.
- Many high-risk fractures can be reduced but any intra-articular gap needs to be less than 2 mm.
- Low-risk fractures may recover more quickly if treated with a brace or supportive bandage.

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