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Pediatrics Tips and Tricks: Initial Management of Pediatric Both Bone Forearm Fractures

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Introduction

Both-bone forearm fractures are among the most frequently encountered types of fractures in children.[1] Due to the unique properties of immature skeleton, guidelines generally dictate a slightly higher acceptable angulation with respect to fixation in developed bone.[2] There is general consensus in opting for closed reduction and casting as opposed to surgical fixation when possible, though current literature has not established the optimal fixation method for forearm fractures.[3] Here, we aim to review the management of pediatric both bone forearm fractures.

Clinical Presentation

Fractures of the radial and ulnar shaft in the pediatric population are most commonly as a result of a fall onto an outstretched arm. Patients will often present with immediate pain and obvious deformity to the forearm, especially if the fracture necessitates reduction. A careful examination of the pediatric patient should include an assessment for any evidence of an open fracture, neurovascular deficits, soft tissue/compartment swelling, and ipsilateral injuries in the upper extremity.[4]

Radiographs

Initial evaluation of both bone forearm fractures should include the usual anteroposterior (AP) and lateral radiographs, including the entirety of the radius and ulna. Dedicated radiographs of the ipsilateral elbow and wrist may often be necessary to fully evaluate the injury.

Generally accepted values for residual deformity varies by age. In patients 10 years or younger, acceptable alignment includes $<$ 15 degrees of angulation, $<$ 45 degrees of malrotation and $<$ 1cm of bayonet apposition or shortening. In patients older than 10 years, acceptable alignment includes $<$ 10 degrees of angulation, $<$ 30 degrees of malrotation and no bayonet apposition or shortening (Table 1). Angulation is typically measured on a radiograph orthogonal to the plane of maximal deformity. Rotation of the radius can be assessed with the location of the bicipital tuberosity and radial styloid, which should be 180 degrees in orientation apart from each other on an AP radiograph. In addition, the ulnar styloid and the coronoid process of the ulna should also be 180 degrees apart from each other on the lateral view (Figure 1).

As these pediatric patients approach skeletal maturity (within 1-2 years of skeletal maturity), it is important to remember that the tolerances of residual deformity become more inflexible as their ability to remodel significantly decreases.[5,6]

Treatment

Non-operative Management

Non-operative treatment for radial and ulnar shaft fractures with closed reduction and casting remains the standard of care.[7] With closed reduction and immobilization, it is important to ensure the restoration of angulation, rotation and length of the fracture within acceptable limits (Table 1). To perform a successful closed reduction of a both bone forearm fracture, adequate analgesia is required; which, in the pediatric population often requires anesthesia or sedation. After closed manipulation of the fracture, it is imperative to apply adequate casting or splinting to maintain the reduction. Principals of casting the forearm include adequate cast padding to protect the skin and bony prominences, adequate molding of the cast to maintain reduction even after swelling resolves, sufficient interosseous mold, straight ulnar sided border and a cast index of $<$ 0.81

Table 1. Satisfactory Residual Deformity of Diaphyseal Forearm Fractures

Age	Angulation	Malrotation	Shortening
0-10 years	<15	<45	<1cm
>10 years	<10	<30	None
Approaching skeletal maturity	0	0	None

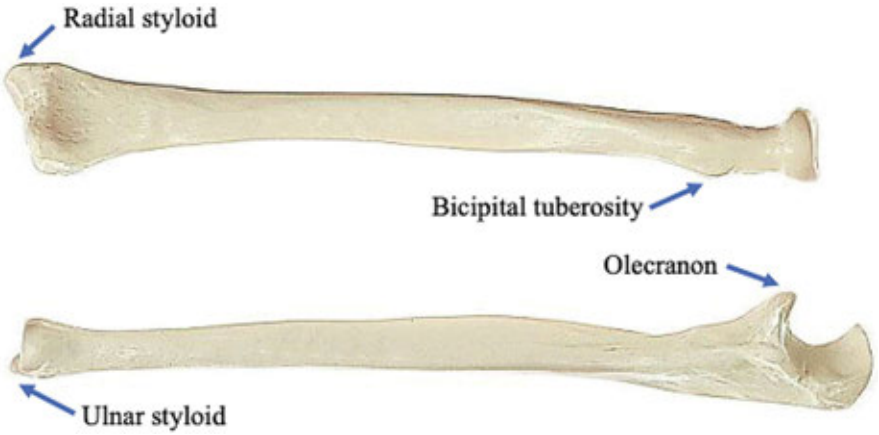

Figure 1. The radius shown from an AP view, illustrating the radial styloid and bicipital tuberosity oriented 180 degrees apart. The ulnar shown from a lateral view, also illustrating the olecranon and ulnar styloid oriented 180 degrees apart.

(the ratio of sagittal to coronal width of the cast at the inner edges of the cast at the fracture site).[8]

The goal with non-operative management of both bone forearm fractures is to achieve acceptable functional outcomes of the upper extremity, with restoration of range of motion of the elbow and wrist and minimal loss, if any, of forearm pronation and supination.[9]

Operative Management

As previously mentioned, the gold standard of care for most forearm fractures in children is non-operative treatment. However, indications for surgical fixation in children and adolescents include open fractures and the inability to maintain an acceptable closed reduction in a cast. As children approach skeletal maturity, acceptable criteria for radiographic displacement becomes comparable to that of adults. Two main options exist in the operative treatment of pediatric forearm fractures: elastic intramedullary nailing and open reduction internal fixation with standard plating technique. Each approach offers its own set of advantages and disadvantages that are at the discretion of performing surgeon to consider in each clinical scenario. Flexible intramedullary nailing has been popularized because it can offer a percutaneous fracture fixation option with less surgical dissection and lower biologic cost. Disadvantages of flexible nails include skin irritation at the tip of the nail, and the need for a second procedure for hardware removal. In contrast, operative fixation with plates requires more extensive surgical dissection at the fracture site but can offer direct anatomic reduction. Despite their differences, intramedullary nailing and plating offer similar outcomes[10] and their use is ultimately, in most situations, based on the surgeon's discretion.

Considerations

There are various relatively common complications that occur with pediatric both bone forearm fractures and its treatment modalities. With closed management, there is a risk of loss of reduction, refracture, loss of range of motion, and cast issues. McQuinn et al. report that that initial displacement of the fracture $>$ 50% and inability to achieve anatomic reduction with closed manipulation as risk factors for re-displacement.[11] They also highlight the importance of an adequate cast mold, with the cast index being the most useful measure of the cast mold.[8,11]

Another complication known to radial and ulnar shaft fractures is the risk of re-fracture, with rates between 1.4-4.9%.[12,13] Residual malalignment of the radius or ulna after reduction can lead to loss of range of motion, particularly in pronosupination. Loss of range of motion could also result from contracture of the interosseous membrane.[14] Providers should be vigilant of developing compartment syndrome which tends to be more common in open fractures, those with ipsilateral distal humerus fractures, and fractures with difficult reductions or surgical treatment.[4,14,15]

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