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Management of forearm fractures in children

Dr.Mohammed Radhi Obaid

Al Muthanna health directorate, Al Rumaitha General hospital.

M.B.CH.B.MSC. (ortho.)

Abstract:

Fractures of the radius and/or ulna occur frequently. Important forearm fracture patterns include complete forearm fractures, Galeazzi fractures, and Monteggia fractures. A fracture of the ulna (usually the proximal third) with concomitant dislocation of the radial head. Typically caused by either a fall on an outstretched and pronated forearm or a direct, forceful blow to the forearm. Fractures of the forearm bones at the elbow level include radial head fractures, while those at the wrist level include distal radius fractures. The mechanism of injury can be low-energy, such as a fall on an outstretched hand, or high-energy, such as a motor vehicle collision (MVC). Clinical presentation is typically characterized by pain near the fracture site, gross deformity, and swelling. X-ray is the main diagnostic modality. Evaluation includes imaging of the forearm; wrist and elbow imaging are added for moderate to severe injuries. Management varies depending on the age group and fracture characteristics, and includes a thorough neurovascular assessment, acute immobilization, pain management, and referral to orthopedics for definitive open reduction and internal fixation or closed reduction and casting.

Key words: forearm fracture, Management, pain.

Introduction:

Childhood forearm fractures are very common and typically occur after a fall on an outstretched hand. Early assessment should focus on identifying an open fracture, neurovascular compromise, and/or associated injuries. Nondisplaced distal forearm fractures other than complete fractures of the distal radius and ulna can then be referred for scheduled evaluation and further management by an orthopedist with pediatric expertise.

Forearm fractures often occur when children are doing activities like playing or participating in sports. If a child takes a tumble and falls onto an outstretched arm, there is a chance it may result in a forearm fracture. A child's bones heal more quickly than an adult's, so it is important to treat a fracture promptly—before healing begins—to avoid future problems.

The forearm is made up of two bones: the radius and the ulna. The radius is on the "thumb side" of the forearm, and the ulna is on the "pinky finger side." Growth plates are areas of cartilage near the ends of the long bones in children and adolescents. The long bones of the body do not grow from the center outward. Instead, growth occurs at each end of the bone around the growth plate. When a child is fully grown, the growth plates harden into solid bone. Both the radius and the ulna have growth plates.

Fractures can occur in one or both bones of the forearm, and in a number of places along the bone:

- Near the wrist, at the farthest (distal) end of the bone In the middle of the forearm
- Near the elbow, at the top (proximal) end of the bone

Forearm fractures are the most common type of fractures in the pediatric population, but, to date, no comprehensive overviews of their epidemiology are available. Naranje et al. using the 2010 NEISS report, estimated in children aged 0 to 18 years, 5,333,722 emergency room (ER) visits, of which 795,925 (14.7%) were fracture related. Forearm fractures account for 17.8% of all fractures in pediatric age [1]. Joeris et al. [2] found forearm fractures to be significantly more frequent in school age children (65%) and adolescents (63%) compared to infants (42%) and preschool children (50%). Both forearm bones were fractured in 50.1%

of cases of forearm injuries and there were significantly more males than females (63.6% vs. 36.4%) [3].

Understanding pediatric forearm anatomy offers important guidelines for treatment in the non operative and operative settings. Anatomically, the ulna is relatively straight and static, it plays a more important role in maintaining forearm stability, especially when subjected to buckling and torsional stress [4]. Radius and ulna are attached by the proximal annular ligament, by the interosseous membrane along the diaphysis, and distally by the ligaments of the distal radioulnar joint and triangular fibrocartilage complex [5]. The radial bow, an apex lateral bend in the radius, increases the range of pronation [6].

Anatomy:

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Growth plates are areas of cartilage near the ends of the long bones in children and adolescents. The long bones of the body do not grow from the center outward. Instead, growth occurs at each end of the bone around the growth plate. When a child is fully grown, the growth plates harden into solid bone. Both the radius and the ulna have growth plates.(7)

There are several types of forearm fractures in children:

- Torus fracture. This is also called a "buckle" fracture. The topmost layer of bone on one side of the bone is compressed, causing the other side to bend away from the growth plate. This is a stable fracture, meaning that the broken pieces of bone are still in position and have not separated apart (displaced).

- Metaphyseal fracture. The fracture is across the upper or lower portion of the shaft of the bone and does not affect the growth plate.
- Greenstick fracture. The fracture extends through a portion of the bone, causing it to bend on the other side. (8)
- Galeazzi fracture. This injury affects both bones of the forearm. There is usually a displaced fracture in the radius and a dislocation of the ulna at the wrist, where the radius and ulna come together.
- Monteggia fracture. This injury affects both bones of the forearm. There is usually a fracture in the ulna and the top (head) of the radius is dislocated. This is a very severe injury and requires urgent care.
- Growth plate fracture. Also called a "physeal" fracture, this fracture occurs at or across the growth plate. In most cases, this type of fracture occurs in the growth plate of the radius near the wrist. Because the growth plate helps determine the future length and shape of the mature bone, this type of fracture requires prompt attention. (9-10)

Epidemiology:

Forearm fractures are the most common fractures in children, representing 40 to 50 percent of all childhood fractures [11]. The distal third of the forearm, involving the radius and/or ulna, is the most common location, accounting for about 75 percent of forearm fractures and 20 to 25 percent of all pediatric fractures [12]. This high incidence can be explained by increased body mass in relation to an overall decreased bone mineral content during growth and development [13]. Most of these fractures will occur in children older than five years [14].

Radiographic features

Forearm fractures are readily diagnosed on plain radiographs, and further imaging is rarely required.

Plain radiograph

AP and lateral X-rays of the forearm are performed.

A radial or ulnar fracture will be visible on at least one view. It is important to determine what type of fracture it is, e.g. transverse, oblique, comminuted.

If there is only one fracture, it is important to look for a second fracture, or see if there is damage to the proximal or distal radioulnar joint: (15)

- Monteggia fracture-dislocation: ulna fracture and dislocation of the radial head at the elbow
- Galeazzi fracture-dislocation: radial fracture and dislocation of the distal ulna from the carpus.

Classification:

Classification Specific classification schemes have not been developed, but fractures are generally categorized according to location, amount of cortical disruption, displacement, angulation, and malrotation. As mentioned previously, we will not address articular fractures, physeal fractures, or fracture-dislocations in this article. Three main types of forearm fractures will be discussed: greenstick fractures, complete fractures, and distal radial metaphyseal fractures. Greenstick fractures are incomplete fractures with an intact cortex and periosteum on the concave surface. These are usually the result of excessive rotational force.

Complete fractures of both bones of the forearm are classified by location as being in the proximal, middle, or distal third. Proper treatment depends on differentiating greenstick and complete fractures. Completely displaced distal metaphyseal fractures of the radius will be discussed separately because of the differences in reduction and outcome. (16-18)

Operative Indications and Technique

Because most pediatric forearm fractures are treated by closed reduction with good results, operative reduction and stabilization are rarely necessary. The indications for surgical intervention in pediatric forearm fractures include (1) open fractures; (2) fractures shortly before skeletal maturity; (3) irreducible fractures, with or without soft-tissue interposition; (4) unstable fractures after reduction; and (5) Monteggia fractures with an unstable radial head and residual ulnar angulation.

Several different techniques are available, including pins and plaster, open reduction and internal fixation with plates, and closed intramedullary nailing of one or both bones. (19)

Percutaneous pinning for unstable but reducible distal radius fractures has also been described; most authors report excellent results in these severe cases. As anatomic reduction is usually not needed, we prefer closed intramedullary fixation of one or both bones. Immobilization in a supplemental plaster or fiberglass long arm cast is generally used; however, in cases of severe soft-tissue injury, it is possible to avoid casting altogether if both bones are rodded with snug-fitting nails.

The advantages of nailing include the need for only one operation (prominent rods can be removed in the office with local anesthesia), lower infection risk, small

scars with minimal dissection, and possibly better postoperative motion. Intramedullary rodding is performed with the patient under general anesthesia. (20)

The arm is prepared and draped, and preliminary reduction is assessed under fluoroscopy. The bone that is easiest to reduce is approached first; if both bones appear to be equally reducible, the normally straight ulna is approached first. A small incision is made over the tip of the ulnar apophysis, and a straight awl is used to gain access to the proximal ulna. A 1.5- or 2.5-mm-diameter rod (with the distal 5 mm bent approximately 30 degrees to facilitate reduction) is placed under fluoroscopy through the proximal fragment, passed across the fracture site, and advanced to within 2 cm of the distal growth plate. (21)

The rod is cut proximally and bent 90 degrees to prevent migration. If the radial fracture can be reduced closed and appears to be stable, the wound is closed over a slightly prominent ulnar pin. A long arm cast is used for 6 to 8 weeks if the reduction or stability of the radius is in question, it should be fixed with a 15- to 25-degree prebent rod. Contouring the center of the rod in this manner will allow reconstitution of the normal radial bow.

Access to the radius is gained through a small distally based incision just proximal to the distal physis. A proximally directed drill hole is placed, and the prebent rod is passed retrograde across the fracture under fluoroscopic control; the rod tip is bent and cut off, and the skin is closed over the prominent end. In general, if both fractures were rodded, the arm should be immobilized for 3 to 4 weeks in a long arm cast. (22,23)

The rod is usually removed 3 or more months after surgery. Complications Malunion Forearm fractures treated conservatively will rarely present with

malreduction that precludes activities of daily living. in those rare cases in which motion loss is greater than 60 degrees, surgical correction can be obtained with drill osteociasis and casting 40 or with open osteotomy and plating.

Both techniques will increase motion; however, better results are obtained when surgical correction is performed within I year of the original fracture. Occasionally, cosmetic concerns will predominate over functional limitations. If that is the case, malunion osteotomy can be performed to improve appearance; however, the patient should be warned of potential motion. (24-26)

Conclusions

These fractures can be successfully managed with closed reduction and casting, however operative fixation may also be required according to the standard criteria of age, angulation of the fracture and the shortening of the Radius and Ulna. Conservative management is still the first line of treatment for pediatric forearm fractures especially in children less than 10 years old. Presently if operative intervention is required, both plate fixation and flexible nailing are acceptable treatment. The intramedullary nails is the method of choice in operative treatment of diaphyseal fractures of the Radius and Ulna because of decreased surgical dissection , retention of biologic factors at the fracture site.

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