# Upper limb fractures in children

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## Abstract

This article provides an overview of upper limb fractures in children from clavicle fractures to fractures of the wrist. We will focus more on common injuries including fractures around the elbow and those of the forearm. We will review the aetiology and classifications of common fractures and discuss appropriate considerations for management to provide a general overview of treatment options. This article will cover injuries that are managed differently from those seen in adults.

**Keywords** Children; clavicle; elbow; forearm; humerus; upper limb

## Upper limb fractures in children

Upper limb fractures in children are very common and account for nearly 75% of all paediatric fractures. They span a spectrum from minor buckle fractures of the distal radius to supracondylar fractures with vascular compromise requiring emergency intervention. The majority of fractures result from low-energy trauma such as a fall from recreational equipment or sporting activity. Particular fractures in infants and toddlers should raise the possibility of non-accidental injury (NAI). The paediatric skeleton demonstrates greater capacity for healing and remodelling than seen in the adult and as a consequence greater angulation, displacement, translation, and shortening can be accepted and reliably expected to heal and remodel without functional deficits. Remodelling is influenced by proximity of the fracture to the physis, the plane of the deformity, age of the child, and the presence of underlying bone disease.

## Clavicle fractures

The clavicle is one of the most commonly fractured bones in children accounting for 10–15% of all paediatric fractures. It is the most common site for obstetric fractures.

### Classification

Allman classified clavicle fractures into three groups based upon anatomical location — middle (I), lateral (II) and medial (III).

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### Mechanism

Middle-third fractures predominate (90%) and are caused by direct trauma, a fall onto the shoulder or excessive lateral compression.

Distal (lateral) fractures account for approximately 5% of clavicular fractures. The injury frequently involves a fall onto the lateral aspect of the shoulder. The lateral clavicle remains cartilaginous until the third decade of life. Fractures can involve the epiphysis but more frequently the metaphysis is affected, which displaces superiorly and the epiphysis remains held in place by the acromioclavicular ligaments. Lateral clavicle fractures represent physeal injuries and as such have tremendous healing capacity.

Medial fractures constitute less than 5% of all clavicle fractures and are commonly Salter–Harris (SH) II fractures. The medial clavicular physis is the last physis to close around age 20–25 years. Very rarely, sterno-clavicular joint displacement may occur and if symptomatic and problematic, computerized tomography (CT) may be required.

### Management

**Midshaft fractures:** conservative management should be the mainstay of treatment.

***Obstetric injuries*** – the affected limb can be strapped to the child's torso with a tubigrip or stockinette for 10–14 days.

***Toddlers—teenagers (<16 years)*** – broad arm sling immobilization for 10 days–3 weeks followed by gentle mobilization. Complete displacement can be accepted with no need for reduction. Parents and the child should be made aware that the fracture will heal with a subcutaneous bump but that this will remodel with time and will not have any functional implications. Sporting activities should be avoided for approximately 5 weeks after discarding the sling.

***Teenagers (>16 years)*** – the results of recent randomized controlled trials have prompted a shift towards surgical fixation of clavicle fractures in adults. Data from such studies have been extrapolated to the paediatric population with an increasing trend towards operative intervention in adolescents aged 15–19.[1] However, the vast majority of fractures unite and can be managed conservatively. When surgery is performed, plate fixation or flexible intramedullary nailing may be utilised. With both options, metalwork removal should be performed following union.

**Distal (lateral) fractures:** treatment is as per middle-third fractures. In cases where the fracture and physeal separation lead to 100–300% displacement, reduction and fixation with periosteal sleeve repair should be considered.

**Medial fractures:** anterior displacement requires supportive treatment while posterior displacement, if causing compromise, may necessitate closed or open reduction with fixation (suture stabilization of the capsule) performed in cases where the fracture is unstable.

**Open fractures:** are an indication for operative treatment; internal fixation is not mandatory with wound management, reduction of the fracture and repair of the periosteal sleeve usually being all that is required. Other indications for fixation include neurovascular injury and fractures causing skin compromise.





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### Complications

- In severe injuries, brachial plexus injuries may be seen.
- Malunion is common but seldom has functional implications; residual subcutaneous deformity will remodel with time but will take 18 months in children.
- Non-union is very rare — is more common after attempts at open reduction.

## Proximal humeral fractures

Comparatively rare injuries accounting for less than 0.45% of all paediatric fractures and up to 7% of epiphyseal fractures.[2] The majority are SH II fractures or metaphyseal fractures. In children under 10 years, metaphyseal fractures predominate while in adolescents physeal injuries are more common. Mechanisms of injury include trauma such as a direct blow in sporting activities or a fall onto an outstretched hand. Displacement and angulation is common owing to the strong muscular pull of the rotator cuff, deltoid and pectoralis major. The proximal fragment is frequently flexed and externally rotated by the rotator cuff while the distal fragment displaces proximally and is adducted by the pull of the deltoid and pectoralis major respectively. The periosteal sleeve is thicker posteriorly and so the distal fragment displaces anteriorly. The long head of biceps tendon may become interposed between fracture fragments.

### Classification

Physeal fractures are classified as per SH; Neer developed a classification based upon displacement with respect to the diameter of the humeral shaft.

### Management

The proximal humerus has immense remodelling capacity with 80% of humeral growth occurring at the proximal physis. The glenohumeral joint demonstrates considerable mobility and can therefore tolerate residual deformity and angulation.

**Metaphyseal fractures:** most metaphyseal fractures can reliably be managed conservatively with collar-and-cuff immobilization utilising the weight of the arm to apply traction to the fracture site. This should be continued for a period of 2–3 weeks with gentle pendular exercises commenced at 10 days. As long as there is 2 years of growth remaining, off-ended and shortened fractures (up to 3 cm) can be accepted. In older children with very displaced fractures, where remodelling will not occur, elastic intramedullary nailing may be used. Other authors advocate closed or open reduction and Kirschner-wire (K-wire) fixation in children over 11 years with displaced and unstable fractures (Neer III or IV).

**Physeal fractures:** the majority are SH II fractures which can be managed conservatively as outlined above. In cases of physeal separation, fixation with intramedullary flexible nails should be performed.

### Complications

- For very displaced fractures, shortening and varus malunion have been reported but are not clinically significant.
- Neurovascular injury to brachial plexus, brachial artery and axillary nerve have been reported but are rare.
- Humeral head osteonecrosis (rare).

## Humeral shaft fractures

Humeral shaft fractures in children are rare and account for 2–5.4% of all paediatric fractures. They are the second most common obstetric fractures. In toddlers and infants, these injuries should raise the suspicion of non-accidental injury (NAI). Spiral fracture of the humeral shaft in children under the age of 15 months is significantly associated with NAI. In one study, 100% of toddlers and infants with this injury were victims of abuse.[3] In older children, blunt trauma is the leading cause of injury.

### Classification

Is based upon anatomical location and fracture pattern.

### Management

Treatment is conservative.

**Infants:** collar-and-cuff immobilization for 1–2 weeks. Positioning the arm under the clothes will help immobilize the limb.

**Toddler — teenagers:** collar-and-cuff immobilization permits the elbow to hang in a gravity dependent position and apply traction at the fracture site. A hanging cast will accomplish the same effect. If the location of the fracture permits, a humeral brace allows for mobilization of the elbow. Treatment duration is determined by the age of the child, stability and callus formation.

**Surgery:** operative intervention is indicated in cases of open fractures, ipsilateral forearm fractures creating a floating elbow, vascular compromise, compartment syndrome (rare), pathological fractures, and polytrauma where fracture stabilization may aid rehabilitation. Surgical options include flexible intramedullary nailing and plate fixation.

### Complications

- Radial nerve injury (4.4%). Outcome is invariably good with recovery seen within several months of the injury.
- Non-union is exceedingly rare; in cases where it does occur, open-reduction and plate fixation may be utilised.
- Overgrowth is seen in approximately 80% but is generally less than 1 cm and is asymptomatic.

## Supracondylar humeral fractures

The most common elbow fracture in children, supracondylar humeral fractures account for 3% of all paediatric fractures. The average age at injury is 5–7 years. They span a spectrum from relatively benign undisplaced fractures, to limb-threatening off-ended injuries with neurovascular compromise. Extension type fractures predominate (95–97%) and are caused by a fall onto an outstretched hand or falls from recreational equipment. In hyperextension, the olecranon engages the olecranon fossa and acts as a fulcrum around which the fracture occurs.




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