



## 11. Fractures and minor head injuries: minor injuries in children II

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*Although many fractures in children can be managed with pain relief and splinting alone, a thorough knowledge of which ones require referral and urgent intervention is essential*

Falls are the most common cause of injury in children presenting to an emergency department.<sup>1</sup> Children, with their relatively large heads, plastic bones, and limited ability to protect themselves during a fall, frequently sustain fractures and minor head injuries. Management of the other types of minor childhood injuries that are frequently encountered — bruising, abrasions, and lacerations — is covered in the previous article in the *MJA Practice Essentials Series – Paediatrics* (*Bruising, abrasions, lacerations: minor injuries in children I. Med J Aust* 2005; 182: 588-592); fractures and minor head injuries will be dealt with in this article.

### Assessment of childhood injuries

As explained in the first article on childhood injuries, we define a minor injury as one that could reasonably be expected to heal with minimal medical intervention. The importance in both fractures and head injuries of distinguishing between “minor” and “major” injuries is emphasised.

In the previous article, we described techniques for increasing the chance of a successful assessment of an injured child, such as gaining the child’s trust, and dealing with pain at an early stage with analgesics, splinting and distraction. Information about analgesia, sedation and local anaesthesia, as well as antibiotics and tetanus prophylaxis, is given in the previous article (see *MJA* 2005; 182: 588-592).

During assessment of an injured child, the child’s immunisation status, allergies to antibiotics or dressings, and any pre-existing medical conditions need to be established.

### Fractures

Common fractures in children involve the clavicle, humerus, radius, ulna, distal tibia, and fibula. Incomplete fractures involving only one cortex are relatively stable and generally can be managed with splinting to relieve pain and prevent further injury.

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### ABSTRACT

- Fractures in children are common, but the plasticity of children’s bones means that they may be incomplete.
- If a child has deformity, swelling or bony point tenderness in a limb after a fall, it is likely to be fractured.
- A fractured limb that appears deformed will most probably need to be reduced.
- Effective splinting, using whatever means is readily available, and early, adequate analgesia, can ameliorate the severe pain associated with a fracture.
- In young children with open growth plates, Salter–Harris type I injuries of the distal fibula are more common than ligament injuries of the ankle.
- After an ankle ligament injury, functional treatment — brace or tapes, with active physiotherapy — results in a better outcome than immobilisation.
- A child with a head injury, who does not lose consciousness, has only one or no episodes of vomiting, and is stable, alert and interactive, and neurologically normal, is extremely unlikely to have sustained an intracranial injury.

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### Fracture assessment

A fracture should be suspected when a child presents with deformity, swelling or localised bony tenderness of a limb after a fall. In very young children, not moving a limb or refusing to bear weight on a limb may indicate the presence of a fracture.

Examine the limb carefully for:

- deformity or swelling;
- point tenderness;
- any skin wound around the injury site, suggesting the possibility of an open fracture;
- neurological impairment distal to the injury;
- peripheral pulses and perfusion distal to the site of injury; and
- signs of compartment syndrome — excessive pain, tense compartment, and pain on movement, especially extension of fingers or toes.

Examine the child for any associated injuries and consider whether the fracture may constitute a non-accidental injury.

An x-ray should be obtained of the suspected fracture site, including the joints on either side. Both anteroposterior and lateral views are necessary for diagnosis. Comparison views of the contralateral side should not be done routinely, but may be helpful in specific circumstances if there is any doubt in interpreting the initial films (eg, around the elbow).

**Describing fractures**

It is important to be able to describe fractures accurately for documentation or discussion with a colleague, especially by telephone. Include in the description:

- Anatomical site of the fracture — “which bone?”, “which side?”, and “is the fracture in the proximal, middle or distal third of the bone?”;

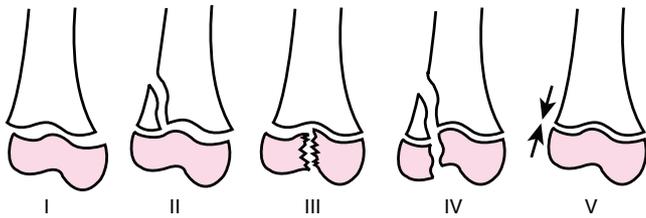
- Appearance of the fracture line — transverse, oblique, spiral, or comminuted (more than one fragment);
- Whether the fracture is open or closed;
- Angulation and displacement of the fracture:
  - to determine angulation, draw a line along the edge of both major fragments and measure the angle of intersection of the distal fragment.
  - to determine the displacement, compare it with the width of the bone at that point (eg, half a diameter displaced or completely displaced).

In metaphyseal fractures (ie, fractures in the expanded ends of long bones), it is important to note the proximity of the fracture to the growth plate, as this determines the remodelling potential of the bone and cartilage around the joint. Injuries to the growth plate are described according to the Salter–Harris classification (Box 1).<sup>2</sup>

**Analgesia**

Fractures are extremely painful. Splinting the limb effectively using whatever means is readily available, and providing early, adequate analgesia can ameliorate the pain. Displaced fractures usually require parenteral analgesia such as intravenous morphine. If this is not available or practicable give a generous dose of paracetamol/codeine mixture.

**1 Salter–Harris classification of epiphyseal injuries**



Type I, fracture through the growth plate; Type II, fracture through the growth plate and metaphysis; Type III, fracture through the growth plate and epiphysis; Type IV, fracture through the growth plate, epiphysis and metaphysis; and Type V, crush or compression injury of the growth plate.

**2 Upper limb fractures (excluding hand fractures)**

Type of fracture	Important issues	When to refer immediately	Management
Clavicle	A lump will develop at the fracture site which may be visible for 1 year No follow-up x-ray is necessary	Fracture is tenting the skin Involvement of acromioclavicular joint Brachial plexus injury	Broad arm sling for 3–4 weeks Adequate analgesia No contact sports for at least 6 weeks No medical follow-up necessary <sup>4</sup>
Surgical neck of humerus		Displaced or markedly angulated	Undisplaced — sling for 3 weeks
Shaft of humerus	Check the integrity of the radial nerve	Transverse, displaced, comminuted	Undisplaced — collar and cuff, with U-shaped slab to reduce movement and minimise pain. Remove the U slab after 2–3 weeks and leave the arm in a sling until pain resolves
Supracondylar region of humerus	Check the integrity of the radial artery, radial nerve, median nerve and ulnar nerve Swollen elbow with joint effusion only indicates an undisplaced fracture — look for displacement of the anterior and posterior fat pads on x-ray	Angulated, displaced or comminuted Look carefully for undisplaced lateral condyle fractures — refer if displaced or any doubt about the diagnosis (see Case study) Vascular compromise needs to be corrected within 4 hours of injury	If vascular compromise is present, extend the elbow until perfusion returns and refer urgently Undisplaced — collar and cuff (under clothing) or backslab with the elbow flexed to 110° for 3–4 weeks
Shaft of radius and/or ulna	Isolated fracture of ulna — look for radial head dislocation (on lateral x-ray) Isolated radial fracture — look for distal radioulnar joint dislocation	Displaced, angulated, open Displacement of the radial head or distal radioulnar joint	Undisplaced — above-elbow cast
Distal radius with or without ulna	Single cortex affected — fracture may appear to be angulated when not Angulations of up to 20° may be acceptable — the older the patient the lesser the degree of angulation allowed If arm looks deformed, then reduction of fracture required	Arm appears deformed Displaced, angulated > 20° — will require manipulation	If a single cortex only is involved, use a short arm cast or backslab for 2–4 weeks Remove cast when fracture site no longer tender If both cortices involved — above-elbow plaster. If angulation increasing, then urgent referral required

**Referral and reduction**

Fractures that are likely to need specialist referral include those that require reduction, open fractures, fractures with neurovascular compromise and fractures involving a joint surface (ie, Salter–Harris type III or IV). Fractures around the elbow joint often require surgical intervention.

The amount of angulation that is acceptable varies with the type of fracture and the age of the child. If the angle between the shaft of the bone and the fractured fragment is greater than 20°, manipulation of the fracture is likely to be needed. As a rule of thumb, if the limb looks deformed at clinical examination then the fracture is likely to require reduction.

**Maintaining fracture position**

A simple undisplaced buckle fracture with only one cortex involved can be treated with an easily removable plaster or fibreglass slab.<sup>3</sup> However, if the fracture involves both cortices of the bone, an encircling plaster or a plaster/fibreglass slab extending across the joint above and below should be used.

If treating a child with an encircling plaster as an outpatient:

- Try to get the child to elevate the limb above chest level for 24–48 hours after fitting the plaster. This may not be possible in small children.
- A sling should only be worn after this period, and the hand should not be below the elbow while in the sling.

- For leg plasters, crutches should only be used by children over 6–7 years of age who have good coordination.
- A review of the plaster should be organised for the day after fitting the plaster to check whether it is too tight. Look for pain on passive extension of the fingers or toes, swelling and colour of the digits, and assess distal circulation. Pain at the fracture site alone is rarely a reason to split a plaster.
- Go through written instructions explaining the care of a child with a plaster to the parents, and give them a copy. For an example, see <[www.rch.org.au/kidsinfo/factsheets.cfm?doc\\_id=4083](http://www.rch.org.au/kidsinfo/factsheets.cfm?doc_id=4083)>.

**Follow-up**

For children who have had a fracture manipulated or whose fracture involved both cortices of the bone, a repeat x-ray should be obtained after 1 week to ensure the correct position is maintained. If a plaster slab has been used, then this should be replaced by an encircling plaster, and a repeat x-ray through the plaster obtained. The plaster cast should remain in place for 3–6 weeks, depending on the site and severity of injury. Following the removal of the cast, the bone is still at risk of re-fracture until the fracture consolidates, which may take 6–12 weeks. Contact sports are not recommended during this period.

Management of the various types of upper- and lower-limb fractures, including those requiring urgent referral, are summarised in Box 2 (upper limb), Box 3 (hand), and Box 4 (lower limb).

**3 Hand fractures**

Type of fracture	Important issues	When to refer immediately	Management
<b>Metacarpals</b>	Fifth is the commonest Look for full extension of fingers Look for rotation of finger with flexion of finger  Acceptable angulation of a metacarpophalangeal neck fracture is 20°, 2nd; 30°, 3rd; 40°, 4th; 50°, 5th	Angulated or rotated shaft fracture (will require pinning)	Undisplaced or acceptable angulation — volar slab with hand flexed at the distal interphalangeal/metacarpophalangeal joint for 3 weeks
<b>Phalanges</b>	Check carefully for rotation at the fracture site (particularly, distal end of proximal phalanx) Intra-articular fractures require anatomical reduction	Displaced or angulated	Undisplaced — strap to the adjacent finger for 3–4 weeks
<b>Mallet finger</b>	Inability to extend distal phalanx	Large bone fragment associated with injury	Mallet splint for 6 weeks non-stop (ie, not to be removed, even to shower)

**4 Lower limb fractures**

Type of fracture	Important issues	When to refer immediately	Management
<b>Tibial fracture</b>	Should be suspected in a child not bearing weight after an injury	Displaced, angulated	Proximal or midshaft — above-knee plaster Distal — below-knee plaster
<b>“Toddlers fracture”</b> (undisplaced tibial or fibula fracture not seen on initial x-ray)	Clinical diagnosis in a young child not bearing weight after an injury and/or with tenderness on palpation of tibia/fibula; x-ray looks normal		Allow as much weight-bearing as the child desires if the pain is minimal, or, if pain at rest or nocturnal pain, fit a below-knee plaster for 2–3 weeks Limping will continue for 6 weeks
<b>Distal tibia/fibula</b>	Refer if articular surface of tibia involved	Displaced, angulated, involving both tibia and fibula	Undisplaced — below-knee plaster for 6 weeks
<b>Metatarsals</b>			Undisplaced or displaced — lower leg plaster slab for 4 weeks. Elevation for the first few days will help minimise swelling

### Ankle injuries

An ankle sprain can be difficult to distinguish, clinically or radiologically, from a fracture through the growth plate of the distal fibula. Young children with open growth plates are more likely to sustain a growth plate injury or a fracture than a ligament injury and should be treated in a plaster cast for 2 weeks and re-examined. If the site is still painful or a repeat x-ray shows a fracture, maintain immobilisation for another 4 weeks. True sprains are more common in adolescents.

#### Clinical assessment of the ankle

- What was the mechanism of injury? (inversion/eversion/crush)
- Was the patient able to bear weight immediately after the injury? (NB: a small child with a minor fracture of the tibia or fibula may continue weight-bearing.)
- Where is the swelling most prominent?
- Where is the point of maximal tenderness?
- Is the ankle stable? (Does the dome of the talus move forward with anterior stress?)

#### Investigation

X-rays are required if any of the following are present:

- Pain over the posterior edge of the distal tibia or fibula.
- Pain over the navicular or head of the fifth metatarsal.
- The child is unable to bear weight for four steps both immediately after the injury and later in the surgery.<sup>5</sup>

#### Evidence-based practice tip

- Fibreglass backslabs or moulded splints are a suitable alternative to traditional full casts in children with a minimally displaced buckle fracture of the distal radius (III).<sup>3</sup>

Levels of evidence (I–IV) are derived from the National Health and Medical Research Council's system for assessing evidence.<sup>11</sup>

These indications for an x-ray examination are commonly referred to as the Ottawa ankle rules.<sup>6</sup> Although they are a useful guide, the Ottawa ankle rules may not be as sensitive at predicting a fracture in children as they have proven to be in adults.<sup>7</sup>

If a child has tenderness over the growth plate of the distal tibia or fibula, and x-rays show no abnormality, treat as a Salter–Harris I epiphyseal injury. If swelling is not marked, apply a below-knee plaster cast for 4–6 weeks. If there is marked swelling, treat in a backslab for 2 weeks, then re-examine. If the area over the growth plate is now no longer tender, mobilise with the assistance of physiotherapy; otherwise, continue the immobilisation. If a fracture is present, an x-ray at this time should show new bone formation.

#### Management of mild-to-moderate sprain (fracture excluded)

##### RICE

**Rest:** advise no weight-bearing for a few days but encourage mobilisation as soon as the acute pain has subsided. Active non-weight-bearing, range-of-motion exercises should begin on Day 1.

#### Case study — a 4-year-old girl with a painful left elbow after a fall

The parents of a 4-year-old girl bring their daughter to you after she has fallen about 1 metre from climbing equipment onto her outstretched arm. The girl is complaining of pain in her left elbow.

She is unable to straighten her arm without pain and can only flex to 110°. The elbow looks swollen, mainly on the medial aspect. She has diffuse tenderness around the elbow and is unable to supinate or pronate her arm. There is no neurovascular compromise.

##### Management

- You administer 15 mL of paracetamol/codeine mixture (total dose of 360 mg paracetamol and 15 mg codeine).
- You place a temporary splint across the joint and put the arm in a sling.

- You order anteroposterior and lateral x-rays of the left elbow (Figure A and B). They show an undisplaced lateral condyle fracture.
- You initially treat the fracture in a backslab and refer the girl to an orthopaedic outpatient department. You suggest to the parents that you review their daughter the following day, or sooner if she complains of pain.
- On review at the orthopaedic outpatient department 5 days later, x-rays show that the fracture is now displaced (Figure C).
- The child is admitted to hospital, and an internal screw is inserted to improve the position and help the healing process (Figure D).



Lateral condyle fractures are inherently unstable and take a longer time to heal than supracondylar fractures. They should be managed by internal fixation in most cases. This case illustrates that it may be difficult to diagnose these fractures and that close follow-up is needed to prevent complications. A and B. Appearance of the child's elbow — initial anteroposterior and lateral x-rays. C. X-ray appearance 5 days after the injury, showing displacement of the condylar fragment. D. Postoperative appearance of the elbow.

**Ice:** this should be applied every 2–3 hours for 15 minutes during the first 48 hours; then heat can be applied.

**Compression:** use either a firm bandage or a plaster slab (for 48 hours only, as prolonged immobilisation will cause stiffness).

**Elevation:** the limb should be elevated on a few pillows whenever possible to allow the swelling to subside.

### Management of severe sprain (fracture excluded)

- Treat in a similar way to a fracture: use a below-knee plaster cast (or, if the swelling is severe, a backslab followed by a full plaster cast) for a maximum of 1–2 weeks. No weight-bearing is allowed for the first few days.
- Gradual rehabilitation should occur after this.

Physiotherapy is useful in all grades of ankle ligament injury. Functional treatment — brace or tapes, with active physiotherapy — has been shown in older adolescents to produce a better outcome than immobilisation, with greater joint stability and an earlier return to sport.<sup>8</sup>

### Pulled elbow (subluxation of radial head)

A pulled elbow is a common injury in toddlers, but it may occur in children up to the age of 5 years. It is most often caused by a person forcibly pulling on the child's arm, but it may also result from a fall, or the mechanism may be unknown.<sup>9</sup>

### Clinical examination

The arm is held pronated and extended (ie, limp by the child's side, as if he or she is ignoring it!). The child is not distressed unless the limb is moved by someone else. Palpation from the clavicle to the wrist does not show any swelling or tenderness (be careful not to pronate or supinate the wrist while palpating it, as this will cause pain and falsely localise the injury). Supination of the arm causes pain and resistance to movement is felt.

### Investigation

If the symptoms and signs are typical of a pulled elbow, no investigations are necessary. If the history is not typical, there is swelling or your attempts at reduction fail, an x-ray of the elbow should be obtained to exclude a supracondylar or radial head fracture.

### Management of a pulled elbow

- Hold the child's hand as if to shake it and with your other hand encircle the elbow with the thumb over the radial head.
- Apply traction and supinate the hand with moderate force.
- Flex the forearm at the elbow all the way to the shoulder. You should feel a pop as the radial head is relocated.

The child should be moving the arm normally within 10–15 minutes.

### Minor head injuries

The most common scenario in head injuries is for a child to fall and hit his or her head, to cry immediately after the fall and become inconsolable for minutes to hours. Younger children may then fall asleep.

A child with no loss of consciousness after the incident and only one or no episodes of vomiting, whose condition is currently stable, and who is alert and interactive, and neurologically normal, is extremely unlikely to have sustained any intracranial injury.

Such a child may be safely managed at home. Parents need to have clear instructions, especially about when to seek urgent medical advice. This should occur if their child:

- becomes unconscious or difficult to rouse;
- becomes confused;
- has a fit;
- develops a persistent headache;
- repeatedly vomits; or
- develops any bleeding or watery discharge from the ears or nose.

Instructions for parents of a child who has sustained a minor head injury are available at: <[http://www.rch.org.au/kidsinfo/factsheets.cfm?doc\\_id=3728](http://www.rch.org.au/kidsinfo/factsheets.cfm?doc_id=3728)>.

Children whose condition is currently stable, and who are alert and interactive, but had a brief period of loss of consciousness or a short period (<2 minutes) of convulsions immediately after the impact, are similarly at low risk of an intracranial injury; however, it is prudent to carefully observe them, in hospital or in the surgery, for 4 hours. Regular assessment of conscious state using the Glasgow coma scale is advisable.

Signs requiring immediate referral to hospital include:

- persisting depression, or deterioration, in conscious state;
- focal neurological signs;
- possible penetrating skull wound; or
- persistent headache.

Children developing these signs require an urgent computed tomography scan of the brain and possible neurosurgical intervention.<sup>10</sup>

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### References

- 1 Clapperton A, Ashby K, Cassell E. Injury profile Victoria 2001. *Hazard* 2001; 54: 1-24. Available at: [www.monash.edu.au/muar/VISAR/hazard/haz54.pdf](http://www.monash.edu.au/muar/VISAR/hazard/haz54.pdf) (accessed May 2005).
- 2 Salter RB, Harris WR. Injuries involving the epiphyseal plate. *J Bone Joint Surg Am* 1963; 45: 587-622.
- 3 Howes M. Bracing for buckle fractures of the distal radius in children. Available at: [www.bestbets.org/cgi-bin/bets.pl?record=00349](http://www.bestbets.org/cgi-bin/bets.pl?record=00349) (accessed Mar 2005).
- 4 Calder JD, Solan M, Gidwani S, et al. Management of paediatric clavicle fractures — is follow-up necessary? An audit of 346 cases. *Ann R Coll Surg Engl* 2002; 84: 331-333.
- 5 Plint AC, Bulloch B, Osmond MH, et al. Validation of the Ottawa ankle rules in children with ankle injuries. *Acad Emerg Med* 1999; 6: 1005-1009.
- 6 Stiell IG, Greenberg GH, McKnight RD, et al. Decision rules for the use of radiography in acute ankle injuries. *JAMA* 1993; 269: 1127-1132.
- 7 Clark KD, Tanner S. Evaluation of the Ottawa ankle rules in children. *Pediatr Emerg Care* 2003; 19: 73-78.
- 8 Kerkhoffs GM, Rowe BH, Assendelft WJ, et al. Immobilisation and functional treatment for acute lateral ankle ligament injuries in adults. *Cochrane Database Syst Rev* 2002 (3): CD003762.
- 9 Schutzman SA, Teach S. Upper extremity impairment in young children. *Ann Emerg Med* 1995; 26: 474-479.
- 10 Munro A, Maconochie I. Indications for head CT in children with mild head injury. *Emerg Med J* 2001; 18: 469-470.
- 11 National Health and Medical Research Council. How to use the evidence: assessment and application of scientific evidence. Handbook series on preparing clinical practice guidelines. Table 1.3: Designation of levels of evidence. Canberra: NHMRC, February 2000: 8. Available at: [www.health.gov.au/nhmrc/publications/pdf/cp69.pdf](http://www.health.gov.au/nhmrc/publications/pdf/cp69.pdf) (accessed Mar 2005).

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