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# Paediatric supracondylar fractures: assessment and management

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## Abstract

Supracondylar fractures of the distal humerus are the most common fracture around the elbow in children. A thorough initial assessment must be conducted to identify any associated neurovascular injury and carefully documented. The assessment should include a vascular examination of the radial pulse, temperature, colour and capillary refill time. A neurological examination must comment on the motor and sensory function of the radial, median and ulnar nerves. X-rays allow an evaluation of the fracture location and type, and the degree of displacement. Immobilisation in plaster is the gold standard treatment for paediatric supracondylar fracture of the humerus where the degree of displacement is within acceptable parameters. Casting should be followed by orthogonal radiographs and a repeat neurovascular assessment of the limb. Oral analgesia and safety netting information should be provided on discharge, and the child reviewed in a fracture clinic within 1 week of the injury. The British Orthopaedic Association Standards for Trauma and Orthopaedics for supracondylar fractures of the humerus in children are useful for junior orthopaedic and emergency medicine clinicians to refer to when dealing with these injuries.

Key words: British Orthopaedic Association for Trauma and Orthopaedics; Fractures; Paediatric trauma; Supracondylar fracture of humerus

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## Introduction

Supracondylar fractures of the distal humerus are the most common fracture pattern around the elbow in children, accounting for 75% of all paediatric elbow fractures (Kuoppala et al, 2009). The most common mechanism of injury is a fall onto an outstretched hand (Skaggs et al, 2015). The fractures are sub-divided into extension and flexion types, with the extension-type pattern accounting for 97–99% of cases (Sinikumpu et al, 2016). Fractures are classified radiologically using the Wilkins modified Gartland classification. Gartland type 1 fractures are stable with intact cortices and minimal displacement, whereas Gartland type 2 and 3 have various degrees of displacement and angulation (Swenson, 1948; Rang et al, 2005; Mulpuri and Wikins, 2012). Radiological examples of this classification system are shown in Figure 1.

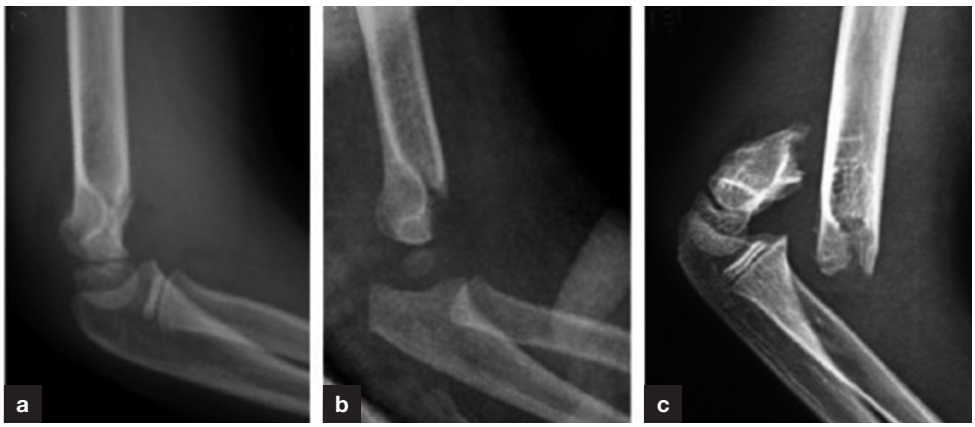


Figure 1. Radiological depiction of supracondylar fractures of the distal humerus (a) type 1 fracture, (b) type 2 and (c) type 3 as described by Gartland. From Vaquero-Picado et al (2018).

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Management of supracondylar fractures of the humerus depends on various factors including integrity of the skin, concurrent neurological or vascular injury, degree of displacement and the presence of compartment syndrome. The consensus in the literature is that an undisplaced fracture can be managed with a 4–6-week period of immobilisation in a cast. Displaced fractures should be managed with open or closed reduction followed by percutaneous pinning with K-wires.

The British Orthopaedic Association Standards for Trauma and Orthopaedics guidelines for supracondylar humerus fractures in children were published in 2020 by the British Association of Orthopaedics. These evidence-based guidelines were produced by a collaborative effort between the Orthopaedic Trauma Society and the British Society for Children's Orthopaedics. These outline the expected level of care for patients in the UK, describing the initial assessment, management and follow up of children with supracondylar fracture of the distal humerus. This article reviews the initial assessment, definitive treatment and follow up of paediatric supracondylar fractures of the distal humerus based on these guidelines.

## Anatomy

The supracondylar region of the paediatric distal humerus consists of a weak, thin bone. This area is bordered posteriorly by the olecranon fossa, anteriorly by the coronoid fossa and on both sides by the supracondylar ridges. This morphology predisposes it to injury in this population. A fall onto an outstretched hand results in the olecranon engaging into the olecranon fossa and, if the force is great enough, the olecranon will act as a fulcrum on the fossa. The anterior humeral cortex will fail first and, if the energy is high enough, the posterior humeral cortex will then fail, causing posterior displacement of the distal fragment with the posterior periosteum acting as a hinge (Vaquero-Picado et al, 2018). This mechanism results in the more common extension pattern of injury.

Flexion-type injuries occur secondary to a direct blow to a flexed elbow (Kasser and Beaty, 2006). The posterior cortex will fail first and, if the energy is sufficient, the anterior cortex will fail and the anterior periosteum will act as a hinge.

## Assessment

### Initial examination and management

The initial assessment, resuscitation and management of a child involved in trauma should follow the approach outlined by Advanced Trauma Life Support (ATLS Subcommittee et al, 2013) guidance.

A documented assessment of the limb should be performed at the time of presentation, assessing skin integrity, swelling and deformity. Open fractures should be managed in accordance with the British Orthopaedic Association (2017) guidelines. The shoulder and wrist should be examined carefully for any concurrent injury.

A full neurovascular assessment should be performed and documented at the time of presentation (British Orthopaedic Association, 2020). Evaluation of vascular perfusion involves palpation of the radial pulse, assessment of capillary refill time, temperature and colour of the skin. If doubt remains, a handheld Doppler can be used to assess for the presence of a radial pulse (Usman et al, 2017). Neurological examination of the upper limb can be challenging in children because of difficulties with understanding and compliance of instructions. A simple game of rock-paper-scissors can be used to assess the motor function of the upper limb: the median nerve flexes the wrist and fingers to make the 'rock', the radial nerve extends the fingers and metacarpophalangeal joints to make 'paper', and the ulnar nerve abducts the first and second digit to make 'scissors' (Davidson, 2003). Additionally, the 'ok' sign can be used to assess the anterior interosseous nerve (Robertson et al, 2012). Sensory function can be assessed in a similar manner to its assessment in adults.

Effective analgesia should be given at the time of initial assessment. Ibuprofen is favoured over paracetamol for paediatric musculoskeletal injuries in the emergency department (Le May et al, 2016).

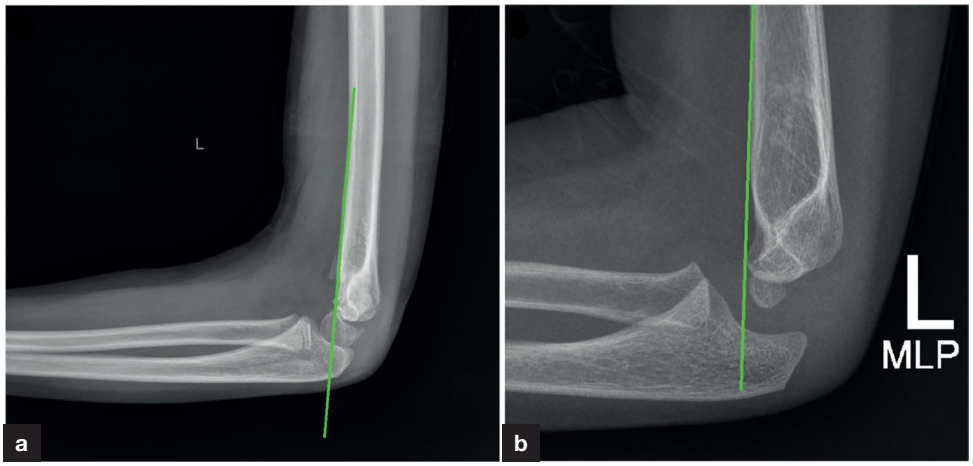


**Figure 2.** a. Normal alignment of the anterior humeral line. b. Anterior humeral line crossing anteriorly in an extension-type fracture. From Sylvia et al (2019).

**Figure 3.** The posterior fat pad sign represented by the asterisk. From Vaquero-Picado et al (2018).

## Investigations

Standard anteroposterior and true lateral X-rays of the elbow should be obtained for the initial diagnosis. These will help to identify the fracture pattern and assess the degree of angulation or displacement, and guide further management. The main anatomical landmark evaluated on X-ray is the anterior humeral line, which is seen on a true lateral view (Abzug and Herman, 2012). This follows the anterior cortical border and transects the capitellum in its middle third (**Figure 2a**). If the fracture is an extension pattern injury, the capitellum will be posterior to the anterior humeral line (**Figure 2b**). In the flexion-type pattern, the opposite occurs, where the capitellum is anterior to the anterior humeral line.

In more subtle fractures, the lateral view can also display the anterior and posterior 'fat-pad sign' which may be the only evidence of an underlying fracture (**Figure 3**). The presence of this sign indicates an underlying fracture in 76% of patients, with 53% of these being supracondylar fractures (Skaggs and Mirzayan, 1999).

The anteroposterior X-ray is used to determine the direction of displacement, the direction of angulation and the presence of comminution. Baumann's angle or the radiological carrying angle can be used to assess the degree of valgus or varus angulation of the distal humerus (**Figure 4**). The radiological carrying angle is preferred, as it is thought to be more accurate than Baumann's angle.

**Figure 4.** A radiological representation of a normal Baumann's angle. From Vaquero-Picado et al (2018).

X-rays are also used to classify the fracture pattern. The most widely used system is the Gartland classification (Gartland, 1959), which is based on description of the degree of displacement of the distal fragment in extension-type fracture patterns. The original classification system is summarised in Table 1. In 1984, Wilkins modified Gartland's original classification system, introducing type 2a and 2b to indicate the absence or presence of malrotation respectively (Wilkins, 1984). Leitch et al (2006) suggested the addition of a type 4 fracture pattern indicating complete disruption of the periosteum, although this can only be classified intraoperatively.

## Management

Gartland type 1 injuries can typically be managed with a short period (4–6 weeks) of immobilisation in a cast in a position of 80–90° flexion and a mid pronation–supination position. Early follow up should be arranged within 10 days to assess for secondary displacement (Vaquero-Picado et al, 2018).

Gartland type 2 and 3 injuries are typically managed with closed or open reduction and percutaneous pinning with K-wires. The initial management of these fracture should be immobilisation in a cast at 30–40° flexion and repeat neurovascular examination. The timing of surgical management is key. These injuries require early surgical management, ideally on the day of admission, although night-time operating is not necessary unless

**Table 1. Original description of distal humerus supracondylar fractures**

| Fracture type | Description |
|---|---|
| Gartland 1 | Non-displaced transverse fractures |
| Gartland 2 | Moderately posteriorly displaced fractures |
| Gartland 3 | Oblique fractures with severe displacement and rotation |

*From Gartland (1959)*

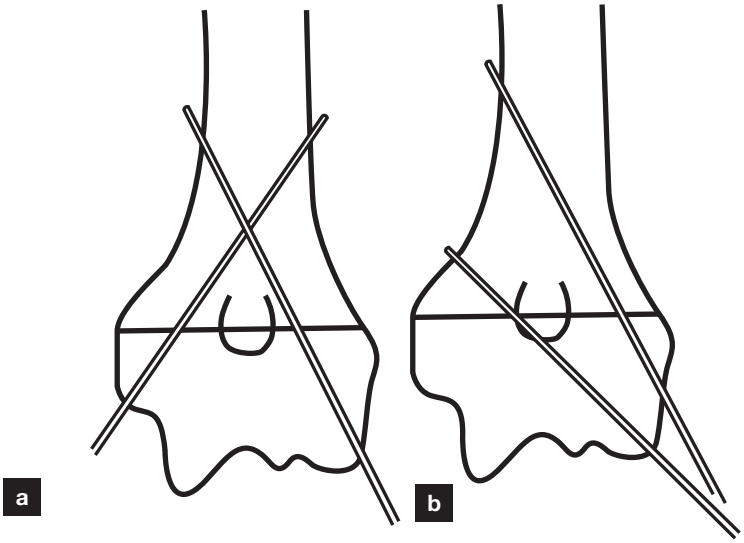


**Figure 5.** a. Crossed wire and (b) divergent wire fixation technique.

urgent surgery is indicated, for example in the absence of a radial pulse, clinical signs of impaired perfusion of the hand or digits and evidence of threatened skin viability (British Orthopaedic Association, 2020). If the patient presents with an ischaemic limb, the case should be discussed with the on-call vascular team before proceeding with surgery. If the limb ischaemia persists after open or closed reduction of the fracture, the brachial artery should be explored by a surgeon competent in small vessel repair (British Orthopaedic Association, 2020).

Surgical fixation should be performed with 2 mm K-wires with bicortical hold where possible. There are two commonly used wire configurations – crossed and divergent lateral (Figure 5) – although crossed wires result in a stronger biomechanical construct and reduced risk of loss of fracture reduction (Zionts et al, 1994; Lee et al, 2002). If crossed wires are used, care should be taken to protect the ulnar nerve when inserting the medial wire, and the method documented clearly (British Orthopaedic Association, 2020). The two lateral divergent wire technique reduces the risk of iatrogenic injury to the ulnar nerve (Skaggs et al, 2001).

Postoperatively the patient's neurovascular status should be examined and documented. This should be continued until the operating surgeon is confident there is no risk of compartment syndrome. Any suspicion of iatrogenic nerve injury should prompt a thorough consultant-led assessment and consideration of nerve exploration. A suspicion of compartment syndrome or deterioration of perfusion should prompt immediate vascular reassessment and intervention if required (British Orthopaedic Association, 2020).

## Follow up

Once the operating surgeon is confident that there is no risk of compartment syndrome and satisfied that the patient's neurovascular examination is stable, the patient can be discharged to outpatient care. The patient should be followed up within 4–10 days for X-rays to ensure there has been no loss of fracture reduction (British Orthopaedic Association, 2020). The K-wires should be removed at 3–4 weeks and mobilisation can then begin. Long-term follow up is not routinely indicated.

## Conclusions

Supracondylar fractures are common in children. Prompt assessment and diagnosis of neurovascular injuries are paramount and should be documented in detail. Hand perfusion is the most important factor in determining the timing of surgery. There is currently no nationally agreed pathway for managing the pulseless supracondylar fracture, so further research is required in this area. The configuration and size of K-wires used for fixation also

## Key points

- Supracondylar fractures are a common injury in children that require prompt assessment and diagnosis, with particular attention given to the neurovascular assessment.
- The perfusion status of the hand is the key determinant of the timing of surgery.
- The British Orthopaedic Association Standards for Trauma and Orthopaedics guidelines should be referred to by any doctor in training managing a paediatric patient with a supracondylar distal humerus fracture.

remains an area of interest. The British Orthopaedic Association Standards for Trauma and Orthopaedics guidelines provide an excellent standard for the diagnosis, assessment and treatment of supracondylar fractures based on current evidence. This is a useful resource for junior orthopaedic and emergency medicine clinicians when treating patients with these injuries.

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**Conflicts of interest**

The authors declare that there are no conflicts of interest.

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## References

Abzug JM, Herman MJ. Management of supracondylar humerus fractures in children: current concepts. J Am Acad Orthop Surg. 2012;20(2):69–77. https://doi.org/10.5435/JAAOS-20-02-069

ATLS Subcommittee; American College of Surgeons' Committee on Trauma; International ATLS working group. Advanced trauma life support (ATLS®): the ninth edition. J Trauma Acute Care Surg. 2013;74(5):1363–1366. https://doi.org/10.1097/TA.0b013e31828b82f5

British Orthopaedic Association. Open fractures. 2017. https://www.boa.ac.uk/asset/3B91AD0A-9081-4253-92F7D90E8DF0FB2C/ (accessed 30 November 2023)

British Orthopaedic Association. Supracondylar fractures of the humerus in children. 2020. https://www.boa.ac.uk/asset/A240155A-F0DD-4BE7-8C8AF7B6CC4DA795/ (accessed 30 November 2023)

Davidson AW. Rock-paper-scissors. Injury. 2003;34(1) 61–63. https://doi.org/10.1016/s0020-1383(02)00102-x

Gartland JJ. Management of supracondylar fractures of the humerus in children. Surg Gynecol Obstet. 1959;109(2):145–154

Kasser JR, Beaty JH. Supracondylar fractures of the distal humerus. In: Beaty JH, Kasser JR (eds). Rockwood and Wilkins' fractures in children. 6th edn. Philadelphia (PA): Lippincott Williams and Wilkins; 2006:543–589

## Curriculum checklist

This article addresses the following requirements from the general internal medicine training curriculum:

- Communicates effectively and is able to share decision making, while maintaining appropriate situational awareness, professional behaviour and professional judgement
- Managing an acute unselected take
- Managing an acute specialty-related take.

Kuoppala E, Parviainen R, Pokka T et al. Low incidence of flexiontype supracondylar humerus fractures but high rate of complications: a population-based study during 2000–2009. Acta Orthop. 2009;87(4):406–411. https://doi.org/10.1080/17453674.2016.1176825

Le May S, Ali S, Khadra C et al. Pain management of pediatric musculoskeletal injury in the emergency department: a systematic review. Pain Res Manag. 2016;2016:1–10. https://doi.org/10.1155/2016/4809394

Lee SS, Mahar AT, Miesen D, Newton PO. Displaced pediatric supracondylar humerus fractures: biomechanical analysis of percutaneous pinning techniques. J Pediatr Orthop. 2002;22(4):440–443. https://doi.org/10.1097/01241398-200207000-00005

Leitch KK, Kay RM, Femino JD et al. Treatment of multidirectionally unstable supracondylar humeral fractures in children. A modified Gartland type-IV fracture. J Bone Joint Surg. 2006;88(5):980–985. https://doi.org/10.2106/JBJS.D.029562

Mulpuri K, Wilkins K. The treatment of displaced supracondylar humerus fractures: evidence-based guideline. J Pediatr Orthop. 2012;32(Supplement 2):S143–S152. https://doi.org/10.1097/BPO.0b013e318255b17b

Rang M, Pring ME, Wenger DR. Rang's children's fractures. Philadelphia (PA): Lippincott Williams and Wilkins; 2005

Robertson JS, Marsh AG, Huntley JS. Neurological status in paediatric upper limb injuries in the emergency department – current practice. BMC Res Notes. 2012;5(1):324. https://doi.org/10.1186/1756-0500-5-324

Sinikumpu JJ, Victorzon S, Pokka T et al. The long-term outcome of childhood supracondylar humeral fractures: a population-based follow up study with a minimum follow up of ten years and normal matched comparisons. Bone Joint J. 2016;98-B(10):1410–1417. https://doi.org/10.1302/0301-620X.98B10.35923

Skaggs DL, Mirzayan R. The posterior fat pad sign in association with occult fracture of the elbow in children. J Bone Joint Surg Am. 1999;81(10):1429–1433. https://doi.org/10.2106/00004623-199910000-00007

Skaggs DL, Hale JM, Bassett J et al. Operative treatment of supracondylar fractures of the humerus in children: the consequences of pin placement. J Bone Joint Surg. 2001;83(5):735–740. https://doi.org/10.2106/00004623-200105000-00013

Skaggs DL, Flynn JM, Waters PM. Fractures in children. 8th edn. Philadelphia (PA): Rockwood and Wilkins; 2015

Swenson AL. The treatment of supracondylar fractures of the humerus by Kirschner-wire transfixion. J Bone Joint Surg. 1948;30(4):993–997

Sylvia SM, Maguire KJ, Molho DA et al. Emergency room closed reduction versus in situ splinting in the treatment of paediatric supracondylar humerus fractures. J Child Orthop. 2019;13(3):334–339. https://doi.org/10.1302/1863-2548.13.190018

Usman R, Jamil M, Hashmi JS. Management of arterial injury in children with supracondylar fracture of the humerus and a pulseless hand. Ann Vasc Dis. 2017;10(4):402–406. https://doi.org/10.3400/avd.oa.17-00050

Vaquero-Picado A, González-Morán G, Moraleda L. Management of supracondylar fractures of the humerus in children. EFORT Open Rev. 2018;3(10):526–540. https://doi.org/10.1302/2058-5241.3.170049

Wilkins KE. Fractures and dislocations of the elbow region. In: Flynn JM, Skaggs DL, Waters PM (eds). Fractures in children. Philadelphia (PA): Wolters Kluwer;1984:363–575

Zionts LE, McKellop HA, Hathaway R. Torsional strength of pin configurations used to fix supracondylar fractures of the humerus in children. J Bone Joint Surg. 1994;76(2):253–256. https://doi.org/10.2106/00004623-199402000-00013