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Supracondylar Humerus Fracture in Pediatrics

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Abstract
Supracondylar humerus fracture is the most common elbow fracture in children, particularly between the ages of 4 and 10 years. This injury typically occurs due to a fall on an outstretched hand, causing indirect trauma to the distal humerus, an area structurally thinner and more vulnerable to fracture. Clinical manifestations include pain, swelling, limited elbow motion, and, in severe cases, deformity or neurovascular impairment. Diagnosis is established through clinical assessment and radiographic evaluation, with key indicators such as the anterior humeral line and fat pad sign. Management is guided by the Gartland classification. Non-displaced fractures (Type I) are treated conservatively with immobilization, while displaced fractures (Types II, III, and IV) generally require closed reduction and percutaneous pinning to prevent complications such as neurovascular injury, compartment syndrome, malunion, and cubitus varus deformity. Early and appropriate treatment is essential to restore function and prevent long-term complications.

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1. INTRODUCTION

Supracondylar fracture of the humerus or supracondylar *humerus fracture* is a fracture that occurs in the distal part of the humerus bone at the level of the epicondyle that passes through the olecranon *fossa* (Sumarwoto et *al.*, 2020). This fracture occurs most frequently in children of all ages, both urban and rural (Kumar and Singh, 2016). Supracondylar fracture of the humerus is the most common fracture occurring around the elbow in children globally and accounts for approximately 50-70% of all pediatric elbow fractures. The age range considered to be potentially susceptible to this fracture is between 4 and 10 years (Shah and Agashe, 2021). A study conducted in Indonesia found that approximately 61.9% of children under 9 years of age are more susceptible to supracondylar humeral fractures if they experience trauma, due to the ongoing bone ossification process (Riansyah and Putra, 2020). When stratified by gender, the incidence is higher in boys than in girls and usually affects the less dominant hand more often (St. Clair and Schreiber, 2022).

Based on etiology, the most common cause of supracondylar fractures of the humerus is an indirect mechanism, namely, when falling, children generally use their hands as support, which indirectly puts pressure on the elbow, resulting in a high incidence of fractures. Factors associated with this fracture include proximal narrowing from the

metaphysis to the diaphysis and anteroposterior thinning of the humerus as the medial and lateral columns fuse at the proximal aspect. *olecranon fossa*, so that this can lead to the emergence of relatively weak points in that area (St. Clair and Schreiber, 2022).

Management of supracondylar humeral fractures includes operative and non-operative management. These fractures can be grouped based on: Gartland classification, which is the most commonly used classification system for management of fracture supracondylar humerus (Shah and Agashe, 2021). Gartland classification is divided into Gartland type I, type II, type III, and type IV (Vaquero-Picado et al., 2018).

Supracondylar humeral fractures have the potential to cause significant morbidity and acute complications such as nerve injury, compartment syndrome, and vascular injury, as well as chronic complications with the possibility of rotational and varus malalignment leading to malunion and cubitus varus deformity (Shah and Agashe, 2021). Seeing the high incidence and risk of this fracture occurring in pediatrics in the world and in Indonesia, followed by the short-term and long-term complications that arise, this is the reason the author wrote this article.

2. RESEARCH METHOD

This article was written using the literature review method. by collecting and analyzing various scientific sources discussing supracondylar humeral fractures in pediatrics. Literature searches were conducted through national and international journal databases such as PubMed*, Google Scholar,* and *Science Direct by* using the keywords "*supracondylar humerus fracture", "pediatric elbow fracture",* and *"Gartland classification".* The literature reviewed was selected based on the relevance of the topic, the credibility of the publisher, and the recency of the information, with a publication period between 2012 and 2022. The collected data were analyzed and systematically arranged into several aspects, namely definition, etiology, epidemiology, pathophysiology, clinical manifestations, radiological examination, and management.

3. RESEARCH RESULTS AND DISCUSSION

3.1.Definition

A supracondylar fracture of the humerus is a fracture or break that occurs in the distal part of the humerus at the level of the epicondyle and passes through the olecranon *fossa* (Sumarwoto, Hadinoto, and Suko, 2020). This elbow fracture is most common in children of all ages, both urban and rural. The supracondylar region in children consists of thin, weak bone in the distal humerus, which is limited by the olecranon bone on the posterior part, the *fossa coronides* on the anterior part, and *the supracondylar ridge on* the lateral side (Kumar and Singh, 2016).

3.2.Epidemiology

Supracondylar humeral fractures are widely considered the most common elbow fracture in children, accounting for approximately 50–70% of all pediatric elbow fractures. Children most at risk of developing this fracture are between 4 and 10 years of age. These fractures are more common in boys than girls, and the non-dominant hand is often affected (St. Clair and Schreiber, 2022).

Approximately 97% of all supracondylar humeral fractures are extension fractures, with only 3-4% being flexion fractures (Shah and Agashe, 2021). Approximately two-thirds of these fractures are inpatient cases requiring surgery.

3.3.Etiology

When falling, children often use their hands for support, resulting in indirect elbow fractures. Associated factors that can cause these fractures include proximal narrowing from the metaphysis to the diaphysis and anteroposterior thinning of the humerus, particularly where the medial and lateral columns join at the proximal aspect. *Olecranon fossa*. This can create a relative point of weakness in the supracondylar region of the humerus.

The distal supracondylar humerus is the most common fracture site in children, particularly between the ages of 5 and 7, with an average age of 6. Extension fractures are more common than flexion fractures, which are more common in older children. This is because children often fall in a supine position, supported by their hands, with the elbows fully extended (St. Clair and Schreiber, 2022).

3.4.Pathophysiology

The ossification process of the distal humerus occurs at different ages. At age 1, the capitulum first appears. Then, at age 4-5, the radial head and medial epicondyle begin to ossify, followed by the trochlear and olecranon epiphysis at age 8-9. The final part to appear is the lateral epicondyle at around age 10. The supracondylar process undergoes ossification. *Remodeling around* the age of 6-7 years causes the cortex to become thinner and slimmer, thus becoming a predisposing factor for fractures in this area (Vaquero-Picado et al., 2018).

The anatomy of the distal humerus is highly susceptible to trauma because it is a structurally weak zone, divided into two columns connected by thin bone (Kumar & Singh, 2016). Based on the AO-ASIF, three types of distal humeral fractures are defined, one of the most common being type A, an extra-articular supracondylar fracture (Blom, Warwick, & Michael, 2018). When falling with an outstretched hand, the olecranon attaches to the olecranon fossa, and if elbow extension continues, the olecranon acts as a support in the fossa. Therefore, the fracture occurs starting anteriorly and then progressing posteriorly. If the energy is high, the posterior cortex will be distracted, ultimately resulting in complete posterior displacement of the distal fragment, with the periosteum acting as a hinge (Kumar & Singh, 2016). When this occurs, the fracture is usually displaced and unstable. This is likely due to the absence of a strong periosteum to anchor the fragment (Blom, Warwick, & Michael, 2018). Flexion fractures, on the other hand, occur with a fall on a flexed elbow, but are less common, representing approximately 1-3% of fractures caused by direct trauma to the flexed elbow (Hope & Varacallo, 2022; Vaquero-Picado et al., 2018). In these cases, the anterior periosteum acts as a hinge, and the injury progresses from the posterior to the anterior portion of the distal humerus. The distal fragment tends to be translated in the coronal plane (Kumar & Singh, 2016).

3.5.Clinical Manifestations

The clinical manifestations of this fracture generally include elbow pain, a history of falls, and limited elbow joint motion, characterized by the child's reluctance to move their arm. Furthermore, the patient experiences swelling around the elbow and deformity (Kropelnicki*et al.*, 1019) (Abzug and Herman, 2012).

Other symptoms that may be found and indicate the need for immediate orthopedic examination are loss of radial pulse, cold and pale hand temperature as a sign of ischemia, severe swelling of the forearm and/or elbow, wrinkled or bruised skin on the anterior part, open wounds, and neurological injury (Kumar and Singh, 2016).

Some other signs that can be found are "*S-deformity*" In extension fractures, ecchymosis, and skin puckering indicate severe trauma. Puckering occurs because the

proximal fragment divides the muscle. *The brachialis* causes the dermis to wrinkle. If skin wrinkles are found in this fracture case, it is necessary to check for soft tissue damage, changes in position. *(displacement)*severe, arterial involvement *brachialis* and *median nerve* (Cowboy-Picado) *et al.*., 2018).

Figure 1. Clinical manifestations of supracondylar humeral fractures

Figure a show the presence of wrinkles antecubital *fossa* which indicates a fracture, thus splitting the muscle biceps *brachii* and *brachialis*. Figure b shows the appearance of S-deformity, which can be found in cases of fractures in the extended elbow joint condition (Vaquero-Picado et al., 2018).

3.6.Radiological Examination

In the lateral view of the radiological examination, several radiological parameters can be found, such coronoid *line*, the *anterior humeral line, the fat pad sign*, and the *fish tail sign*. Findings *pad sign* without any obvious fault line, indicating the presence of a hidden fracture (Kumar and Singh, 2016).

Figure 2. Fat-pad sign posterior (Vaquero-Picado et al., 2018).

3.7.Management

Management of supracondylar humeral fractures includes operative and non-operative management. The choice of treatment must take into account complications such as neurovascular disorders, the possibility of the outcome of the therapy chosen, and the severity of the injury experienced by the patient. Management can be based on the Gartland classification (Kropelnicki*et al.*, 2019).

a. Gartland type I

Fracture non-displaced. Type I fractures can be easily managed with a cast or long-arm splint. There is usually no severe swelling or ecchymosis, so elbow flexion up to 80° to 90° and mid-pronation-supination are well tolerated. However, elbow flexion in a cast should not exceed 90° because it can increase forearm pressure and impede distal vascular flow. Although secondary displacement is rare, radiographs can be obtained to control for secondary displacement. This is done at least seven to ten days after the injury. Three weeks after the fracture, the cast is removed and progressive joint motion can be performed (Alfonso et *al.*, 2018).

b. Gartland type II

Operative treatment for these fractures has become more popular in recent years. The limited potential of *remodeling* the distal humerus is a reason to support surgical management. The distal humerus only accounts for 20% of total bone growth and repair capacity after age four. After age eight to ten, only 10% of humeral growth remains, so anatomical reduction is considered imperative. *Closed reduction* and *casting have* become less popular because excessive elbow flexion beyond 90° is required to maintain reduction, which increases the risk of compartment syndrome and neurovascular injury (Alfonso et *al.*, 2018).

c. Gartland type III and IV

It is known that type III and type IV fractures must be treated surgically. Currently, *closed reduction* and *percutaneous pinning are* the standard for all displaced fractures. The Blount method with closed reduction and elbow hyperflexion to maintain reduction is no longer used due to the risk of compartment syndrome or neurovascular injury (Alfonso et *al.*, 2018).

The indications for surgical intervention include:

a. Unstable fracture (failure to maintain reduction) after closed reduction
b. There is neurological involvement that occurs after or during fracture manipulation.
c. Closed manipulation failed to achieve a reduction.
d. Polytrauma with multiple ipsilateral fractures requiring surgical intervention
e. Open fracture
f. Vascular exploration is required
g. All type II and III fractures requiring elbow flexion of more than 90°$^{\text{the}}$to maintain reduction
h. All supracondylar fractures of the humerus are type IV (Kumar and Singh, 2016).

4. CONCLUSION

A supracondylar fracture of the humerus is a fracture in the distal humerus at the level of the epicondyle and passes through the olecranon fossa. Globally, this is the most common elbow fracture in pediatrics, especially the extension type. Clinical manifestations include elbow pain and a history of falls. In severe cases, ecchymosis and wrinkling are found, *accompanied* by symptoms of nerve impairment and peripheral ischemia. Management can be based on the Gartland classification. Non-displaced fractures, or Gartland I fractures, can be treated with a cast or long-arm splint, while Gartland II, III, and IV fractures are treated with surgery.

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