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An Overview on Management of Supracondylar Humerus Fractures

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Abstract:

Supracondylar humerus fractures (SCHF) are the most common elbow injuries in children, typically occurring between the ages of 5 and 7. They result from falls onto an outstretched hand and often require urgent attention due to the risk of neurovascular complications. Timely diagnosis and appropriate management are essential to prevent long-term functional impairment and deformities such as cubitus varus.

Keywords: Supracondylar humerus fracture, SCHF, pediatric elbow fracture, Gartland classification, closed reduction, percutaneous pinning, neurovascular complications.

Introduction:

Supracondylar humerus fractures (SCHF) are the most frequent elbow injuries in children, especially between the ages of 5 and 8, accounting for nearly 70% of pediatric elbow fractures **(1).** These injuries usually result from falls on an outstretched hand, with extension-type fractures being most common. Due to the anatomical complexity of the elbow and the proximity of vital neurovascular structures, SCHF can lead to serious complications if not managed promptly and appropriately.

The Gartland classification remains the most widely accepted system for categorizing these fractures and guiding treatment decisions. Non-displaced (Type I) fractures are typically managed conservatively with casting, while displaced (Type II and III) fractures often require surgical intervention, most commonly closed reduction and percutaneous pinning (CRPP). Recent studies have emphasized the importance of early surgical fixation within 24 hours to minimize risks of compartment syndrome, malunion, and neurovascular compromise.

Emerging evidence has also supported the use of lateral pinning over crossed pinning in certain cases to reduce the risk of iatrogenic ulnar nerve injury, without compromising stability **(2).** Despite advances in treatment techniques, challenges remain in ensuring optimal outcomes, especially in severely displaced or open fractures.

All patients should be assessed according to Advanced Trauma Life Support (ATLS) principles. A non-accidental injury should be excluded in all pediatric injuries **(3).**

A. Conservative management:

Non-operative management is acceptable for nondisplaced Gartland I and minimally displaced Gartland IIA fractures. Management of GartlandII fractures has been controversial. Gartland II injuries can be managed non-operatively, provided that fracture alignment is satisfactory. Displacement and malunion can occur in the presence of medial column comminution. There is a risk of medial column collapse, leading to a cubitus varus deformity**(4).**

A recurvatum deformity secondary to malunion can occur if the anterior humeral line does not intersect the capitellum on lateral radiographs. These three factors: medial comminution, posterior displacement, and excess swelling, are contraindications to non-operative management of Gartland II fractures **(5).**

Non-operative management involves immobilization in a collar and cuff, or an above-elbow cast with the elbow in 80-90 degrees of flexion for three to four weeks. Excess swelling can compromise the vascularity of the forearm and lead to compartment syndrome. Above elbow, casts have been found to provide more effective pain relief than the use of a collar and cuff for Gartland I fractures **(6).**

Several studies found that patients with Gartland II displaced fractures had satisfactory functional outcomes when managed in a cast, although some developed cubitus varus. Excessive flexion should be avoided in patients with significant elbow swelling. Traction has been used historically for displaced fractures. It may be used in low-resource settings in low- and middle-income countries where there is limited access to equipment for surgical treatment **(7).**

B. Surgical management:

Surgical management is indicated for displaced Gartland II and Gartland III fractures. Urgent surgical management is indicated for patients with neurovascular compromise, compartment syndrome, and open fractures. For closed injuries, surgical management involves closed reduction and percutaneous pinning with K-wires **(4).**

Open reduction may be required for failed closed reduction, irreducible fractures, and for vascular exploration. Orthopedic surgeons managing these intricate fracture patterns with potential concomitant neurovascular injuries should ensure that they can handle the associated injuries and have a vascular surgeon on hand for assistance during the surgery **(8).**

1. Closed Reduction and Percutaneous Pinning:

This is indicated for Gartland IIB and III fractures. It is also indicated for Gartland IIA fractures if an acceptable reduction is not obtained in a cast and if there are any contraindications to non-operative treatment (e.g., medial column comminution) **(3).**

1. Closed Reduction:

Closed reduction involves in-line traction with 'milking' of the soft tissues when a pucker sign is present. Traction pulls the fracture out to length, and 'milking' helps release the soft tissues. Traction should be applied with the elbow in slight flexion **(9).**

This is followed by the correction of coronal plane displacement: medial/lateral translation and varus/valgus angulation of the distal fragment. Pronation with a valgus directed force or supination with the addition of a varus force may be required, and these maneuvers also help correct rotational deformity **(10).**

Pronation helps to correct posteromedial displacement (internal rotation) while tightening the medial periosteum while supination can help correct posterolateral (external) rotation. The sagittal plane deformity is corrected by hyperflexion of the distal fragment in extension-type fractures. The extension may be required in flexion-type fractures. The joystick technique has been described as a method to aid the reduction ofmulti-directionally unstable fractures **(7).**

2. Percutaneous Pinning Technique:

Lateral pins and crossed pins (medial and lateral) biocritical constructs can be used. Lateral pin configurations are frequently used, and they reduce the risk of iatrogenic ulnar nerve injury. Two or three lateral pins may be used. Pins must be inserted in a parallel or divergent manner with maximal separation between them. For lateral pins, a capitellar starting point also provides improved construct rigidity compared to a direct lateral entry point **(4).**

Pin Configuration:

- **Two-K Wire Technique**: The most common technique involves the use of two K-wires inserted percutaneously. This method provides sufficient stability and alignment in most cases. Studies indicate that the two-pin technique yields favorable outcomes with a low incidence of complications as seen in figure 1**(11).**

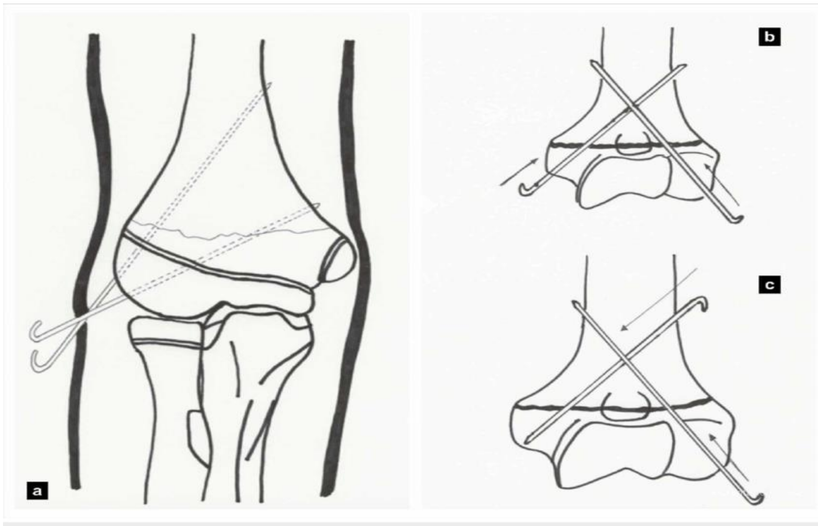

Fig1: K-wire configuration for fixation (a) Lateral divergent technique, (b) Cross K-wiring technique, and (c) Dorgan's technique (11).

3. **Three-K Wire Technique**: Some studies advocate for a three-pin technique, believing it provides enhanced stability and reduces the risk of displacement as seen in figure 2 **(11).**

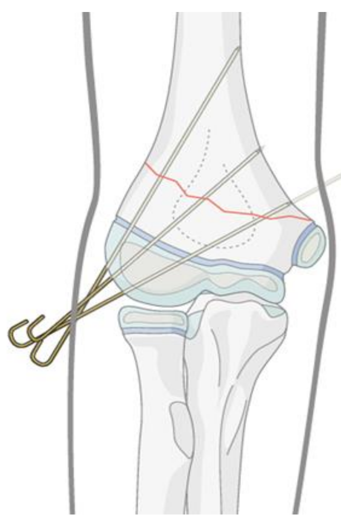

Fig2: lateral pinning of SCHF using 3 k-wires (11)

A trans olecranon fossa four-cortex purchase has been described as a technique for lateral pinning to increase construct rigidity. Pin size has been shown to affect the stability of the fixation. 2 mm pins have been found to provide improved biomechanical strength compared to 1.6mm pins **(6).**

The use of crossed pins increases the risk of iatrogenic ulnar nerve injury; however, they improve the torsional rigidity of the construct compared to the use of two lateral pins. A medial incision should be made of an adequate size that will allow the protection of the ulnar nerve before insertion of a medial pin **(12).**

The insertion of percutaneous medial pins should be avoided due to the risk of nerve injury. A further way to reduce the risk of iatrogenic ulnar nerve injury is to extend the elbow while inserting the medial pin. This maneuver displaces the nerve more posteriorly **(8).**

2. Open Reduction and Percutaneous Pinning:

Open reduction is necessary when reduction cannot be achieved by the closed method. In particular, soft tissue/neurovascular structures can become trapped in the fracture site preventing anatomical reduction. Open reduction may also be necessary for open fractures. Exploration of the brachial artery via an open approach is required in cases where perfusion is not established peri-operatively following reduction and fixation of the fracture **(10).**

Open exploration of the brachial artery in the setting of an absent radial pulse but perfused hand following reduction and fixation remains controversial. An anterior approach has been recommended for open reduction. Alternative approaches include medial, lateral, and posterior approaches **(3).**

3. Vascular Exploration:

Urgent vascular exploration is indicated in patients with a pulseless, pale hand. This needs to be performed by a surgeon experienced in the repair of small vessels or conjunction with a vascular surgeon. An attempt at closed reduction and fixation of the fracture should be performed in the first instance to see if this restores perfusion to the limb **(9).**

The management of patients with a pink, perfused, but pulseless hand following reduction and fixation remains controversial. These patients need close observation following surgery. Non-operative management has been shown to yield acceptable results. Some patients with a pulseless, perfused hand may go on to develop ischemia, and this patient cohort necessitates urgent vascular exploration as shown in fig 3,4 **(8).**

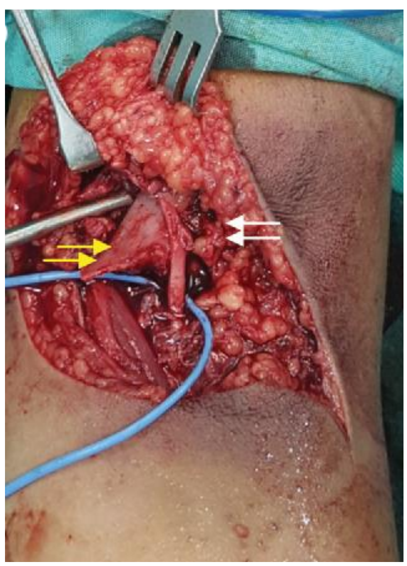

Fig 3: Intra-operatively, the brachial artery is partially lacerated (white arrow) by the sharp edge of the metaphyseal spike (yellow allow). The median nerve appears intact (8).

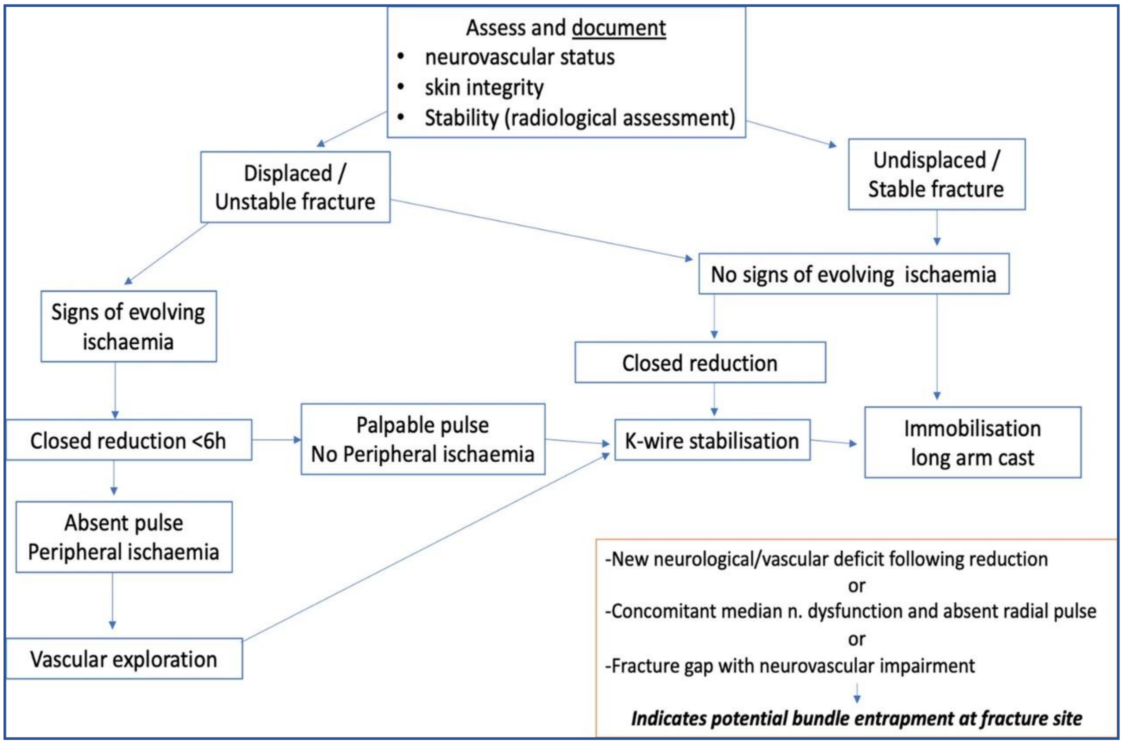

Fig.4: Management flowchart for supracondylar fractures related to adequate and inadequate perfusion (7)

4. **Postoperative and Rehabilitation:**

Percutaneous pins can usually be removed at the 4-week point post- operatively according to the union characteristic of the fracture.

Radiographic signs of union in supracondylar fractures include the presence of bridging trabeculae across the fracture site, fading of the fracture line, and the restoration of continuity in the cortical bone. These changes indicate that the healing process is progressing appropriately and that the bone is beginning to regain structural integrity. Clinically, signs of union are observed through the absence of pain or tenderness at the fracture site, the gradual restoration of elbow motion within functional limits, and, where applicable, the child's ability to bear weight through the affected arm.

Children can then be allowed to commence mobilization as able. Children may experience some stiffness immediately following removal of immobilization; however, this has been shown to improve in the first month after surgery rapidly. Older children regain range of motion more slowly compared to younger children. Physiotherapy has not been found to improve outcomes in a randomized controlled trial **(6).**

Children and their parents/carers should be counseled about the severity and prognosis of these injuries. Nondisplaced and minimally displaced fractures have the best long-term outcomes **(4).**

5. Prognosis of SCHF:

Prognosis depends on the remodeling potential of the bone, patient, and injury-specific factors **(13).**

Remodeling depends on the following factors the age of the patient and the amount of growth remaining, the distance of a fracture from the physis, plane of deformity, degree of displacement **(6).**

The distal humerus physis provides 20% of the longitudinal growth of the humerus. As a result, the supracondylar region of the distal humerus does not have a significant ability to remodel in cases of malunion. At the elbow, the sagittal plane deformity has better remodeling potential than coronal plane deformity **(6).**

Patient Factors:

Children younger than five years old have better remodeling potential than those older than five. After age five, children have limited residual growth of the distal humerus **(8).**

Injury Specific Factors:

- Grade of injury.
- Adequacy of reduction and fixation.
- Neurovascular status of the limb **(3).**

Appropriate treatment on time improves the long-term prognosis of these injuries. The prognosis may be worse for higher-grade injuries; however, anatomical reduction, stable fixation, and appropriate care of the soft tissues (including neurovascular injuries and compartment syndrome) improves outcomes **(5).**

Nondisplaced Gartland I fractures usually heal well without complication. Gartland II fractures with medial comminution can develop cubitus varus if this is not recognized, reduced, and stabilized. Gartland III and IV injuries are more likely to be associated with neurovascular injuries; however, timely appropriate treatment can lead to excellent outcomes **(12).**

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