

Percutaneous K-wiring for Gartland type III supracondylar humerus fractures in children

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ABSTRACT

Objectives: To assess the ability of closed reduction and percutaneous K-wire fixation, to obtain and maintain an adequate reduction, and thereby achieve satisfactory end results.

Methods: A prospective study conducted on 60 children over 28 months at Jawaharlal Nehru Medical College, Aligarh Muslim University, Aligarh, India, from March 2003 to June 2005, in which Gartland type-III supracondylar fracture humerus were treated by closed reduction and percutaneous pinning, either from lateral side only or from medial side also, under image intensifier control.

Results: There was no problem in union. Patients were graded by Flynn's criteria with excellent results in 88.88%, good in 4.44%, and fair in 2.24%, and poor in 4.44% cases. Only one patient had developed cubitus varus deformity and one had Iatrogenic Ulnar nerve palsy from medial pin, which recovered subsequently. The Baumann's angle was well within the normal range of 66-84°.

Conclusion: Percutaneous K-wire fixation is a safe and effective method for the management of Gartland type-III supracondylar fractures with minimal hospital stay and without risking vascular compromise.

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Around the elbow, the most common fracture in children is supracondylar fracture of humerus. Displaced supracondylar fractures have a very sinister presentation with higher probability of neurovascular injuries. They also have a higher rate of displacement, and if not reduced and stabilized in optimal position, may lead to serious residual deformity. Displaced supracondylar fractures of humerus have always

presented a challenge in their management. Over the years, the history has been studded with various workers in search for developing better modalities of treating this "misunderstood" fracture. Different treatment modalities have been reported ranging from skin traction in abduction; Skeletal traction,¹ closed reduction and plaster cast immobilization; closed reduction and percutaneous pin fixation to open reduction, and Kirschner (K) wire fixation. Percutaneous fixation with K-wires^{2,3} has advantage of: 1. Stable fixation of the fracture fragments. 2. There is decreased risk of circulatory compromise in the form of restoration of radial pulse in nearly 90% of cases of brachial artery injury. 3. It is simple and cost effective procedure. The hospital stay is decreased as compared to traction group. Many of the supracondylar fractures are unstable after reduction except in the acutely flexed position. If considerable swelling is present, this acutely flexed position may compromise circulation and predispose to Volkmann's ischemic contracture.² Immobilization in the safer, right angle position will often allow the fragments to slip, producing various deformities. The purpose of this study was to assess the ability of closed reduction and percutaneous K-wire fixation, to obtain and maintain an adequate reduction, and thereby achieve satisfactory end results.

Methods. This study was a prospective observational study of displaced supracondylar fractures of humerus in children attending orthopedic in the outpatient department or the emergency section of Jawaharlal Nehru, Medical College and Hospital, Aligarh Muslim University, Aligarh, from March 2003 to June 2005. Attempt of closed reduction was carried out under intravenous sedation, and if unsatisfactory, the patient was admitted for closed reduction and percutaneous K-wiring. The fractures were classified according

to Gartland⁴ classification: Type I - "Undisplaced fracture". Often, the fracture line is difficult to see. The diagnosis is made by clinical examination, which reveals tenderness both medially and laterally over the distal humeral condyles. Though, radiographs may show no cortical disruption, a posterior fat pad sign is often present. Type II A - "Hyperextension/Posterior Cortex Intact". It is a greenstick fracture with anterior angulation such as posterior tilt is present on lateral radiograph. Type II B - "II A with rotational deformity". There is posterior tilt with rotational deformity, but the posterior cortex is in contact. Type III - "Completely Displaced". There is no bony contact among the proximal and distal fragment. The displacement can be either posteromedial or posterolateral.

Open fractures were classified according to Gustilo and Anderson's⁵ classification for open fractures. Distal neuro vascular status was checked, mainly the radial artery pulsations. All cases with vascular involvement were identified for immediate definitive treatment in the form of closed reduction and percutaneous pinning. After adequate level of general anesthesia, patients was laid supine on orthopedic table, with the choice of armrest based on surgeons' discretion, however, it is preferable not to use the armrest. The position of the fracture was checked under image intensifier and the displacements noted. Accordingly, closed reduction was carried out by the standard method of traction, countertraction and displacement correction, and forearm flexed maximally to maintain reduction. The correction was checked under image intensifier - the Jone's view and the lateral view.

For the lateral view, it is advisable to rotate the C-arm, rather rotating the arm of the child as it leads to displacements. Once complete reduction was achieved, K-wire (either 1.5 mm or 2.0 mm according to bone of the child) was passed first from lateral condyle, proximally and obliquely upwards, preferably using power drill, while keeping the wire in center in the lateral view and checked under image intensifier. If the K-wire placement was adequate, the elbow was extended to 50-70° for the medial K-wire insertion, otherwise, the lateral K-wire was placed again until proper position achieved. The extension of elbow also allowed measurement of Baumann's angle.⁶ The medial K-wire was passed after palpating the ulnar nerve and pushing it posteriorly (**Figures 1 & 2**). In most cases, ulnar nerve palpation was difficult due to gross swelling. So, pressing the medial condyle for some time pushes the swelling for easy palpability of ulnar nerve, and also, the K-wire was placed somewhat anteriorly over the medial epicondyle to avoid ulnar nerve injury and inserted from proximally to laterally and obliquely and checked under image intensifier.

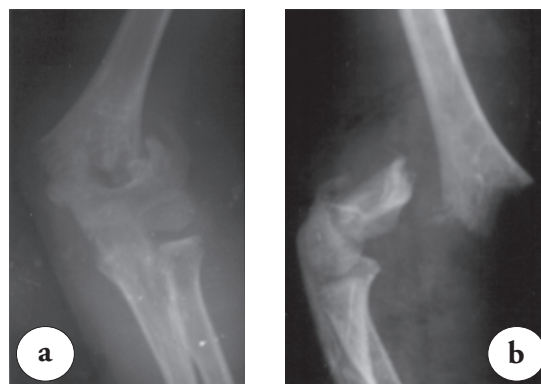


Figure 1 - a & b) Anterio-posterior and lateral view of elbow showing Gartland type-III Supracondylar fracture in a 9-year-old child.

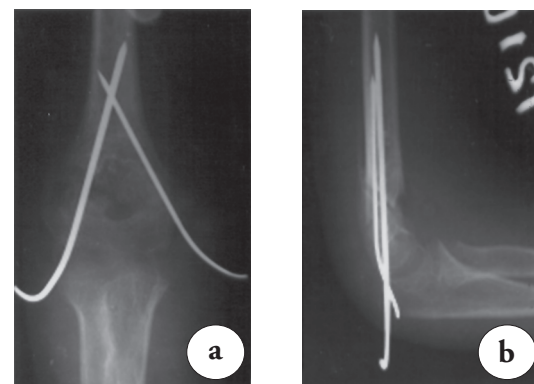


Figure 2 - a & b) Immediate post-operative antero-posterior and lateral view of elbow after closed reduction and percutaneous K-wire fixation.

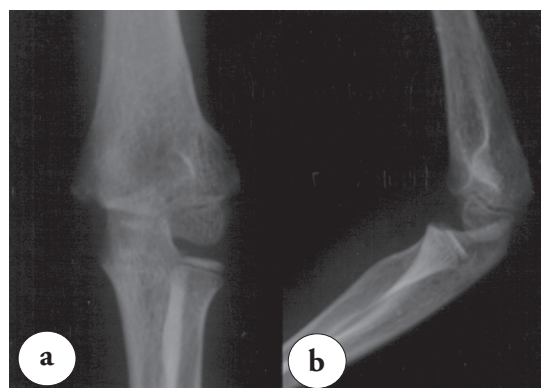


Figure 3 - a & b) Anterio-posterior and lateral view of elbow 6 months postoperative. Wires have been removed.

Then the pins protruding outside skin were bent to 90° to prevent proximal migration and then they were cut. In compound, fractures also after wound debridement reduction was carried out and above protocol of percutaneous K-wiring was followed. After pin tract, a posterior pop slab was applied in all cases. Postoperative x-ray was taken the next day, and the patient was discharged to review after 3 weeks. The slab was removed after 3 weeks and the elbow was inspected for any pin tract infection or migration of pins. X-ray of the elbow was taken and then assessed for union, and K-wire removal completed (**Figure 3**). The patients were then advised active physiotherapy of the elbow. For associated nerve injuries, the passive physiotherapy of fingers and wrist was explained accordingly. Finally, the patients were graded according to Flynn's criteria³ into excellent, good, fair and poor result. Excellent result being 0-5 degree loss of carrying angle and similar degree of loss of motion of elbow; those with 5-10 degree loss of carrying angle and loss of motion were classified as good. The results were labeled as fair when there was loss of 10-15 degrees and poor when over 15 degree loss of carrying angle and motion of elbow.

Results. A total of 60 cases were studied. Thirty-seven were males (61.67%) and 23 were females (38.33%), thus, giving a male to female ratio of approximately 1.5:1. The age of patients ranged from 3-13 years. The mean age was 8.1 years. The right elbow was involved in 29 cases (49%), while the left elbow was involved in 31 cases (51%). Thus, almost both sides were equally involved. The most common mode of injury was fall from height on outstretched hand with elbow extended. Fifty-two cases (86.6%) were closed fractures and 8 (13.4%) were open fractures. Four cases were grade I, 2 cases were grade II, and the other 2 cases were grade III B. There was no grade III A fracture. Grade III C fracture were not included in the study, as in all these cases, open reduction with exploration of Brachial artery was carried out. All the patients had pain and swelling around the joint, and movement of the affected elbow were grossly restricted and painful. All cases were extension type of supracondylar fracture. No flexion type of fracture was encountered. Out of 60 cases, 18 were Gartland type II and 42 were Gartland type III fractures. Out of the 42 Gartland type III fractures, 32 cases were of posteromedial type, and 10 cases of posterolateral type. Thus, posteromedial types of fracture were 2.5 times more common than posterolateral type. Associated injuries were seen in 5 cases. Three cases had ipsilateral fracture of radius and ulna in distal 1/4th, one was simple buckling and the other 2 were displaced fractures. One patient had Type II epiphyseal injury of ipsilateral distal end radius. The last

case had along with supracondylar humerus fracture, an ipsilateral Type II epiphyseal injury distal end radius with fracture distal end ulna, and also had contralateral fracture of radius and ulna in distal 1/4th. Six cases (10%) had radial nerve injury. Two (3.3%) cases had median nerve injury. No patient had associated ulnar nerve injury due to the fracture. All the nerve injuries recovered in an average of 8-12 weeks post injury with no residual disability. Two cases (3.3%) had absent radial artery at the time of presentation, closed reduction was carried out immediately and pulse returned in both cases. In all the 60 cases, closed reduction was tried, however, it failed in 7 cases. In these 7 cases, open reduction with K-wire fixation was carried out. Thus, in 53 cases, closed reduction and percutaneous K-wiring was carried out. Eight cases were lost in follow-up; so, 45 cases were included in the study. Percutaneous K-wiring with 2 lateral pins was carried out in 14 cases (31.1%). Cross K-wiring with one lateral and one medial pin was carried out in 30 cases (66.6%). In one case, 2 lateral pins and one medial pin was used. The K-wires were removed at an average of 3.2 weeks from data of operation ranging from 3-5 weeks. On the anteroposterior view of post-operative x-ray, the Baumann⁶ angle ranged from 66-84° with an average of 72.8°. The only patient with 84° of Baumann⁶ angle was the patient who developed a cubitus varus deformity. For measuring Baumann⁶ Angle, a template was used as described by Williamson.⁷ Six patients had a loss of range of movement within 5° of the normal side, and 2 cases had a loss of range of movement within 5-10° of normal side. In one case, loss of range of movement from 10-15° occurred and in one patient over 15° of loss of extension occurred. All the others (66.6%) regained full range of movements at the elbow, as compared to normal side. Cubitus varus of 17° occurred in one patient (from +7 to -10 degrees), although he had full range of motion at elbow.

Ulnar nerve injury due to medial pin occurred in one case. The ulnar nerve recovered within 8 weeks of the iatrogenic injury. Forty patients had excellent results (88.88%), 2 cases had good results (4.44%), one patient had fair result (2.24%), and 2 patients had poor results (4.44%). Over all, 95.5% cases had satisfactory results and 4.5% had unsatisfactory results, according to the Flynn's criteria. On comparing the results in patients with lateral K-wiring and cross K-wiring, both had equivalent results, as far as functional and cosmetic result was evaluated.

Discussion. The displaced supracondylar fracture of the humerus is a difficult injury to manage. Due to the anatomy of the supracondylar humerus in the susceptible age group, obtaining and maintaining a stable closed reduction of the displaced fracture without internal fixation is difficult. Even in those

patients in whom anatomic reduction can be achieved, loss of reduction may occur as swelling subsides. The position of stability of the fracture is usually flexion of more than 100°. This may not be desirable when significant swelling is present, which is usually in this fracture. Traction requires a longer period of hospital stay, and also, less reliable in children and has no added advantage over immediate closed reduction and percutaneous pinning.^{8,9} The problems with closed reduction and above elbow pop slab or cast, is the risk of re-displacement of the fracture,¹⁰ thus, giving rise to secondary deformities. Open reduction and K-wire fixation has the risk of infection and joint stiffness. Pirone et al;¹⁰ France and Strong¹¹ compared the various modalities of treatment of supracondylar humerus fracture and found percutaneous pinning to be superior. The results in patients with lateral K-wiring as compared to cross K-wiring were equivalent. Cross pinning is theoretically more stable biomechanical construct,¹² however, it adds to the risk of ulnar nerve injury especially when fracture is associated with swelling, as ulnar nerve palpation becomes difficult. In our study, both groups had comparable results. Cheng et al¹³ and Topping et al¹⁴ compared lateral and cross K-wiring, and found equivalent excellent results in both groups. It is advisable to rotate the C-arm of image intensifier than rotating the arm of the child to see the lateral view while doing reduction peroperatively. The early removal of K-wire at 3 weeks and then the starting of physiotherapy reduce elbow stiffness and early recovery of range of movements. Ipsilateral fracture of the forearm is easily managed by this technique. Like many authors,¹⁵⁻¹⁷ it is recommended that brachial artery injury should be managed by immediate closed reduction and percutaneous pinning.^{18,19} In 90% cases, pulse returns,¹⁵ and if not, then exploration of artery should be carried out. One patient who developed cubitus varus of 17° had been operated with 2 lateral pins, however, it was not the fault of the pins, but an unsatisfactory reduction was the cause of it. He had Baumann⁶ Angle of 84 degrees, above the normal range of 64-81 degrees.

Thus, summarizing closed reduction and percutaneous pinning, is a safe and effective method for treating displaced supracondylar humerus fracture in children.^{20,21} For those who are willing to become proficient in this technique, this method will be ideal for management of displaced supracondylar fractures in children.

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