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Original Research Article

To Evaluate the Results of Lateral Pinning and Crossed Pinning Technique in the Treatment of Displaced (Gartland Type III) Supracondylar Fractures of Humerus in Children

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Abstract

Introduction: Supracondylar fractures of the humerus are the most common elbow fractures in the pediatric age group mainly in age group of 3-12 years, mainly due to trauma by fall from height while playing. Closed reduction and percutaneous pin fixation is considered standard management for displaced supracondylar fractures of the humerus in children. However, controversy exists regarding whether to use an isolated lateral entry or a crossed medial and lateral pinning technique. The aim of this study was to evaluate outcomes of surgery by crossed pinning and lateral pinning technique in displaced supracondylar fractures of the humerus in children.

Material and Methods: Between March 2021 to February 2022, of total 60 patients, were divided into two groups; group-A (two lateral k-wires) and group-B (two crossed medial and lateral k- wires) with 30 patients in each group. All children with suspected supracondylar fracture of elbow were seen either at orthopedic emergency room or orthopedic OPD. Anteroposterior and lateral radiographs of the elbow were done. Preoperative investigations (blood picture and prothrombin time & concentration etc.) were done for all cases in our study. Patients were reassessed in the ward for neurovascular injuries and later surgery was performed after taking consent from patient parents or near relatives.

Conclusion: Compared with lateral pinning entry, crossed pinning entry had a higher risk of iatrogenic ulnar nerve injury and increased structural stability. However, in the subgroups, crossed pinning with mini-open incision has decreased the risk of iatrogenic ulnar nerve injury. Therefore, the recommended strategy for the treatment of pediatric SCHF is crossed pinning entry with a mini-open incision, which can provide a stable elbow and avoid iatrogenic injury of the ulnar nerve.

Keywords: Supracondylar humerus fractures (SCHF), Iatrogenic ulnar nerve injury , Crossed pinning, Lateral pinning,gartland classification.

Introduction

The pediatric age group, supracondylar fractures of the humerus are the most common elbow fractures[1,3]. Although they are common between the ages of two and twelve years, the peak is between the ages of four and six. About 98% of these fractures are observed in extension type after a fall on an open arm[3].

Current methods of treatment of supracondylar fracture of humerus in children is based on Gartland classification[3]. Closed reduction and percutaneous pinning are the preferred treatment methods for the surgical treatment of Gartland type III supracondylar humerus fractures in which posterior and anterior cortex contact is discontinued[4,5]. However, there is no consensus on which of the pin fixation method is more useful.

There are well-known complications associated with supracondylar fractures and their treatment—neurovascular injury, compartment syndrome, and malunion leading to cubitus varus[6]. In displaced fractures the incidence of vascular compromise has been reported between 12%[7]. and as high as 19-20% [7]. The amount of neurological complication has ranged between 10% and 20%, with the most common nerve palsy being the anterior interosseous nerve[7,8].

Various treatment options has been discovered for type III supracondylar fracture such as closed reduction and long arm cast or slab, Dunlop skin traction, olecranon traction, but all of these methods had significantly large complication rate[9]. The standard current treatment for displaced supracondylar fracture has been close reduction and percutaneous pin fixation. This method has consistently given excellent results reported by various authors[10,11]. However, controversy persists regarding whether medial and lateral crossed pin fixation or lateral pin fixation is satisfactory technique in terms of stability and iatrogenic ulnar nerve injury[12].

Ideally medial and lateral pin fixation engage medial and lateral column at fracture site whereas lateral pin stabilizes lateral and central column. Medial and lateral pin fixation has been presumed to be more stable but it can cause iatrogenic ulnar nerve injury. Therefore, we conducted this prospective study to compare whether lateral pin construct, if placed properly, can provide the same stability like medial and lateral pin fixation, at the same time avoiding the possibility of iatrogenic ulnar nerve injury.

Materials and methods

It is a prospective randomized study of children with extension type displaced surpracondylar fracture (Gartland type III) admitted in Orthopaedic Department of Bundelkhand medical college hospital Sagar M.P between march 2021 to February 2022, to assess the results of fixation of displaced supracondylar humeral fractures in children by two lateral pins versus crossing medial and lateral pins after taking an informed consent from child's parents or near relatives.

A. The inclusion criteria were:

a. Early fractures within first four days.

b. No associated fracture in the same limb.

c. No previous fracture in the same elbow.

d. Age between 2-15 years

e. Extension type gartland type III fracture**.**

B. The exclusion criteria were:

a. Fracture requiring open reduction.
b. Open fractures.
c. Floating elbow.
d. Flexion type of fracture
e. Fracture with neurovascular deficit.

Between March 2021 to February 2022, of total 60 patients, divided into two groups; Group-A(two lateral wires)) and Group-B (two crossing medial and lateral wires) with 30 patients in each group. All children with suspected supracondylar fracture of elbow were seen either at orthopaedic emergency room or orthopaedic outpatient department by orthopaedic resident doctor and the orthopaedic senior surgeon. They were assessed for evaluation of the general condition, associated other injuries and assessment of the vascular and neurological status of the affected limb.

Anteroposterior and lateral radiographs of the elbow were done. All displaced supracondylar fractures were admitted and injured elbow was immobilized in splint with elbow in 70 to 90o of flexion according to the vascular condition of the affected limb with elevation. Patients were reassessed in the ward for neurovascular injuries. Surgery was planned on the same day or next day after obtaining written informed consent from child's parents or near relatives.

Preoperative investigations (blood picture and prothrombin time & concentration etc.) were done for all cases in our study. Patients were randomly selected by drawing lots with even number included in group A (two lateral wires) and odd number in group B (medial and lateral wires). Surgical techniques were standardized in terms of pin location, the pin size (weight less than 20kg size 1.5mm and more than 20 kg size 2mm.), stability on table, position of elbow for medial and lateral pin placement and the post operative course.

Surgical technique: Surgery was performed by orthopedic surgeon who is well trained for this technique. Regional anesthesia was used for all patients. Closed reduction was done and confirmed by image intensifier. If acceptable, assistant would clean and drape the limb along with image intensifier and surgeon goes for scrub. Fracture would be reduced again and fixed under image intensifier according to the selected configuration.

For the lateral fixation technique two pins were inserted from lateral aspect of elbow across the lateral cortex to engage the medial cortex keeping the elbow in hyperflexion. For the pin construct to be acceptable and biomechanically stable one pin had to be placed in lateral column and another in central column. Pins were placed as much as possible in parallel configuration with the adequate separation at fracture site.

For the medial and lateral fixation technique, first the lateral pin was inserted from lateral cortex across the lateral cortex to engage the medial cortex keeping the elbow in hyperflexion. Then the elbow was extended to less than 90o.Medial epicondyle was located and ulnar nerve was rolled back with opposite thumb and the medial pin was inserted from the medial cortex to engage the lateral cortex with the elbow in less than 90o of flexion. The pin configuration was considered to be acceptable if one pin was placed in lateral column and another pin in medial column. Pins were cut short above the skin with good sterilized dressing to avoid the pin site local infection. Elbow was immobilized with posterior slab with elbow in 90 to 100o of flexion depending upon the swelling and neurovascular status.

All patients were given single dose of broad spectrum antibiotics followed by oral antibiotics for five to seven days. Neurovascular examination was performed preoperatively and immediate post operatively and at one week follow ups. All

the patients were evaluated clinically and radiologically at one week, three weeks, four weeks, two months, three months and four months. In both groups the K wires were removed in three to four weeks and active assisted mobilization started.

Postoperative care: A long arm posterior plaster splint is worn for 3 weeks. Ulnar, radial, and median nerve functions were checked after anesthesia was over. The pins were removed at 3-4 weeks, and intermittent active range of motion exercises are started at home; they should be taught by physical therapist to the child and the parent, explaining that the child is to carry out his own active range of motion program.

Passive motion or forceful manipulative motion must be avoided in children because they will decrease the range of motion and frighten the child. Clinical evaluation was done by senior orthopaedic surgeon which includes passive range of motion, measurement of carrying angle, neurovascular status, superficial and deep infection and necessity to re-operate.

Clinical evaluation was graded according to carrying angle and elbow range of motion using the criteria of Flynn et al.[13] Radiographic evaluation was performed by anteroposterior and lateral radiographs of the elbow. Satisfactory fixation was confirmed intra operatively under image intensifier and radiograph taken postoperatively. Follow up radiographs were taken at one week, three weeks, four weeks, two months, three months and four months. Baumann angle and Humerocapitellar angle were calculated on the immediate radiographs and after three months for any loss of Baumann angle and Humerocapitellar angle.

At the three months and four months follow up child were evaluated for full function, minor limitation of function and major loss of function. Iatrogenic ulnar nerve injury was evaluated immediate postoperatively who had normal ulnar nerve function on the preoperative examination. Any patient with immediate post operative ulnar nerve deficit was put under intensive follow up.

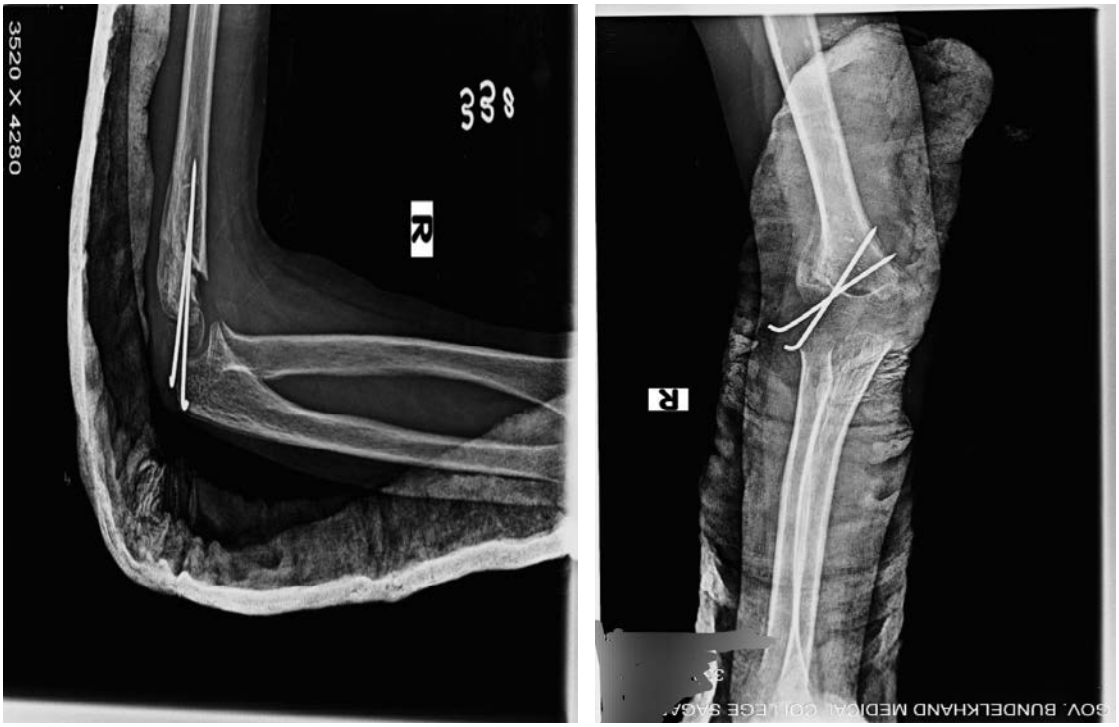

Figure 1: X-rays showing fixation with 2 lateral pins

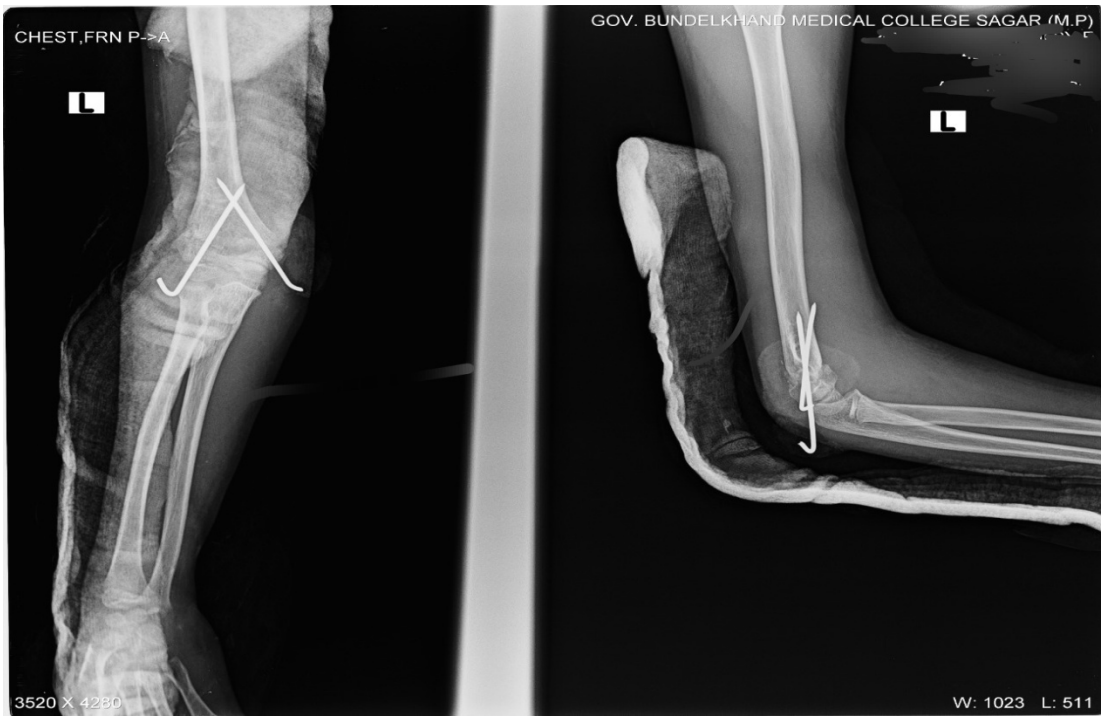

Figure 2: X-rays showing fixation with crossed pins

Methods of Follow Up

***Clinically:** Neurological and vascular assessment,range of motion, deformity and stiffness.

***Radiologically:** Follow up X-rays using antero-posterior and lateral views.

Results:

Results are as shown in the following tables

Table 1: Patients data

Data of the patients	Group – A	Group – B	P-value
No. of patients	30	30	
Age* (yrs)	6.4	6.2	0.451
Sex @			
Male	19	21	0.234
Female	11	09	
Mode of trauma @ Fall from height while Playing	14	15	
Road Traffic accident	12	10	0.312
Other	4	5	
Affected side			
Right	17	14	0.642
Left	13	16	
Displacement @	12	11	0.318

Posteromedial			
Posterolateral	10	10	
Posterior	8	9	
Injury-Hospital Duration hr.*	15±10	20±8	0.303

*The values are given as the mean and standard deviation. @The values are given as the number of patients.

Table 2. Patients results

	Group-A	Group-B	P-value
Loss of reduction			
Major	0	0	
Mild	8	2	0.042
None	22	28	0.411
Iatrogenic Ulnar nerve injury @	0	3	0.632
Bauman angle loss*(deg)	5.10±5.0	4.8±5.2	0.478
Humerocapitellar angle loss*(deg)	5.8±5.2	6.0±5.1	0.267
Carrying angle loss*(deg)	3.30±4.25	3.17±4.15	0.698
Elbow flexion loss*(deg)	8.4	7.6	
Elbow extention loss*(deg)	2.9	3.2	
Range of motion*(deg)			
Extension	-2	0	
Flexion	127	120	0.217
Total motion	125	120	
Flynn grade@			
Excellent	25	22	0.321
Good	3	3	0.521
Fair	2	2	0.421
Poor	0	3	
Superficial Infection@	10	12	0.459
Re-operation@	0	0	
Hospital-Treatment Duration hrs.*	16.5±2.7	16.9±2.6	0.218
Return to function@			
Full	25	22	0.421
Minor limitation	5	5	0.321
Major limitation	0	3	

*The values are given as the mean and standard deviation. @The values are given as the number of patients.

Discussion

The crossed pinning fixation has been demonstrated to be more reliable biomechanical stability[14], while the method leads to an increased risk of iatrogenic damage to the ulnar nerve versus lateral pinning fixation[14]. Because lateral pinning fixation has the risk of reduced stability, it is often necessary to insert more lateral pins to increase stability.

Our study suggested that children with SCHF undergoing lateral pinning fixation had low rates of iatrogenic ulnar nerve injuries but there are high chances of loss of reduction in follow up. However, the loss of reduction rate

was lower in the crossed pin fixation group but threre were higher chances of itrogenic ulnar nerve injury. The Baumann angle, carrying angle, change in Baumann angle, Flynn criteria scores, return to full function, loss of carrying angle, loss of elbow extension, loss of elbow flexion, pin tract infections, and superficial infections were not significantly different between the two treatment groups.

Medial wall communication is a contributing factor to loss of reduction in the management of type III supracondylar fractures. Cross-pinning should be preferred when medial wall communication is present, to provide more stable fixation.

However, the authors believe that in certain fracture configurations, especially those with medial-sided comminution, the medial pin is still required for a stable construct, as postoperative instability has been described in such patients with lateral-only pinning. After the starting point is confirmed, Swenson[15] initially proposed drilling the pin on an acutely flexed arm to maintain reduction of the fracture. However, this is not recommended, and we feel that it is critical for the pin to be passed with the elbow in relative extension so as to prevent anterior subluxation of the ulnar nerve over the medial epicondyle.

The surgeon can readily correct residual extension simply by applying an anteriorly directed force on the distal humeral fragment using the thumb of the free hand when advancing the K-wire. We believe that iatrogenic ulnar nerve injury almost always results from an incorrectly placed pin (the starting point is often inferior to and/or posterior to the medial epicondyle). Although there have been reports showing that the ulnar nerve may migrate to the anterior aspect of the medial epicondyle in about 20% of cases in children[16,17]. In our experience with the present groups, we did not encounter a single case of twitching of the ring and little fingers when the medial pin was advanced.

Another proposal was that by Gordon et al.[18] and Green et al,[19] who recommended the use of a small medial incision to directly visualise the nerve. For adequate visualisation, the incision made must be at least 10 mm in length. Some studies reported that the risk of iatrogenic ulnar nerve injury could be greatly reduced through the placement of a medial pin with a medial mini-incision on the medial epicondyle and the extension of the elbow[18-21]. The risk of iatrogenic ulnar nerve injury associated with medial pin entry could be resolved after wound exploration and placement of the medial pin at a proper location.

Compared with lateral pinning entry, crossed pinning entry had a higher risk of iatrogenic ulnar nerve injury and increased structure stability. However, in the subgroups, crossed pinning with mini-open incision, direct visualization of nerve and its protection from injury by pin has decreased the risk of iatrogenic ulnar nerve injury. Therefore, the recommended strategy for the treatment of pediatric SCHF especially with medial comminution is crossed pinning entry with a mini-open incision, which can provide a stable elbow and avoid iatrogenic injury of the ulnar nerve.

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