

"PROSPECTIVE INTERVENTIONAL STUDY TO ASSESS FUNCTIONAL OUTCOME OF DISPLACED SUPRACONDYLAR FRACTURE OF THE HUMERUS IN CHILDREN (3-14YRS.) MANAGED BY TRANS-OLECRANON FOSSA FOUR CORTEX PURCHASE LATERAL PINNING"

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Abstract:

Aim: To assess the functional outcome of displaced supracondylar fracture of humerus in children (3 to 14 years) managed by transolecranon fossa four cortex purchase lateral pinning.

Methods: A prospective study was conducted in the Department of Orthopaedics, SMS Medical College and Hospital, Jaipur, Rajasthan June 2020 to October 2021. Total 39 children's with displaced supracondylar fracture of Humerus in aged between 3- 14yrs. Type II and III fractures were included in this study. These patients were treated by transolecranon fossa four cortex purchase lateral pinning under C-arm guidance. The outcome was assessed clinically by Flynn's criteria and radiologically by Skaggs's criteria.

Result: Among 39 patients, 30 were male and 9 were female. The fracture was extension type in all 39 patients. Left side was involved in 22 patients and right side in 17 cases. The average age was 6.1 yrs. Based on Gartland classification 16 patients had type-II and 23 patients had type III pattern. Minimal complications were noted in our study. As per Flynn Criteria 33 were excellent, 6 Good, 1 was fair.

Conclusion:

According to our study, if a uniform standardized operative technique is followed in method, then the TOF-FCP of percutaneous fixation method will be safe and effective. for displaced supracondylar fractures of Humerus in pediatric age group.

Keyword's: Humeral fractures; Fracture fixation, internal; Olecranon process/injuries

Introduction:

Supracondylar humerus fractures are the most common pediatric fractures around the elbow account for nearly three-fourth of all upper-extremity fractures.¹ Supracondylar fractures of humerus represent 50–70% of all elbow fractures in children during first decade of life.² The typical age group is 2 to 12 years and typical mechanism of injury is fall on outstretched arm with elbow in full extension. According to the displacement of distal fragment, supracondylar humerus fracture is divided into extension type 97.8% and flexion type 2.2%.³

Gartland's classification is used to describe this fracture and it is based on displacement in coronal plane radiographs. Type I: undisplaced fractures or minimally displaced fracture with intact anterior humeral line. Type II hinged fractures with the posterior cortex intact, and Type III completely displaced fractures, breach in the posterior cortex. Later, Leitch et al., Added type IV, describing multidirectional instability.⁴

The goals of treating supracondylar humerus fracture are to restore accurate close reduction, stable K-wire fixation and early mobilization of elbow joint and achieve full range of motion.

The standard method of managing displaced extension type (Gartland Type II and Type III) supracondylar humerus fractures is closed reduction and percutaneous Kirschner wire (pin) fixation. The non-operative management of unstable supracondylar

fracture of humerus including skin traction, skeletal traction and cast application has historically been associated with a greater incidence of failure to obtain and maintain fracture reduction as well as carries higher complication rates.

There are many techniques of percutaneous Kirschner wire (pin) fixation. Current preferred method of treatment for displaced pediatric supracondylar fracture of humerus has been closed reduction and percutaneous pin fixation which has given excellent results as reported by various authors.⁵ The most commonly used configuration of pinning are medial, lateral crossed pinning and two lateral pinning (parallel and divergent pinning). Biomechanically, a crossed pin configuration (one medial and one lateral) provides increased stability, but carries the risk of iatrogenic ulnar nerve injury during insertion of the medial pin.⁶ Conversely, lateral pin fixation avoids the danger of iatrogenic ulnar nerve injury, but has been proven to be mechanically less stable compared to crossed pin configuration.⁷ Among this, a continuous debate persists between cross pinning (lateral and medial K wires) and lateral pinning. Medial pinning carries risk of iatrogenic ulnar nerve injury whereas lateral pinning is blamed for its instability.^{8,9}

Lateral pinning may result in rotationally unstable fixation causing varus collapse and cubitus varus deformity along with additional medial comminution at the fracture site.¹⁰ Biomechanical studies have shown that chances of rotational loss of reduction in conventional lateral pinning constructs are high compared with cross pinning, indicating that cross pinning has greater torsional stability.¹¹ There are studies which have proven that lateral pinning fixation is good enough for maintaining reduction while simultaneously avoiding injury to the ulnar nerve.¹²

There has been dearth of studies, deliberating the configuration of pins when using only lateral pins, i.e. whether to use the pins in parallel or divergent configuration, only notable study of significance was Lee (2008)¹³ et al study.

In our study, we planned to modify the standard two parallel Lateral pinning technique to make it a more stable construct by achieving a trans-olecranon fossa four cortical purchase, hence this technique could be used universally in all pediatric displaced supracondylar fracture of humerus including unstable fracture patterns.

Material and Methods

A prospective interventional study was conducted in the Department of Orthopaedics, SMS Medical College and Hospital, Jaipur, Rajasthan, India, June 2020 to Oct. 2021, after taking the approval of the protocol review committee and institutional ethics committee. After taking informed consent detailed history was taken from the patient or the relatives if the patient was not in good condition. The technique, risks, benefits, results and associated complications of the procedure were discussed with all patients. Total 39 children's with displaced supracondylar fracture of Humerus in aged between 3-14yrs. Any associated neurovascular injuries, fractures, compartment syndrome were noted. Radiograph of the elbow was taken in Anteroposterior and lateral views. The diagnosis was confirmed by radiological examination. The fractures were classified according to Gartland's classification. All patients were taken up for surgery as soon as possible after necessary routine preoperative hematological investigation.

Gartland's classification

- Type-I Non-displaced
 - Type-II Minimally displaced with intact posterior cortex
 - Type-III Completely displaced with no cortical contact
1. Postero-medial
 2. Postero-lateral

Inclusion Criteria -

- All closed type II and type III Gartland SCFH .
- Age group 3 to 14 years of age.
- Fracture duration less than 7 days.
- Patients who were fit for anesthesia and surgery.
- Parents who gave written informed consent and were willing for follow up.

Exclusion Criteria -

- Gartland type I fracture
- Open fractures and fractures with compartment syndrome.
- Vascular injury demanding repair.
- Patient requiring open reduction.

Surgical Approach :

Patient was placed in supine position. General anesthesia was given, the part was prepared with antiseptic lotion and draped properly. Manual traction was given to the limb with elbow at 20° flexion to correct the mediolateral displacement (coronal alignment) and rotation. The distal fragment “milking” was done with both thumbs of the operating surgeon on the flexed elbow of the patient leading to correction of the posterior displacement (sagittal alignment). The reduction was checked under image intensifier. Reduction was considered “acceptable” with the following criteria fulfilled: no step on medial and lateral columns and normal orientation of olecranon fossa in the antero-posterior (AP) view, tear drop restoration, crescent shape shadow and 40° anterior tilt of capitellum in the lateral view when satisfactory reduction was achieved, the forearm was strapped to arm with maximum possible flexion and pronation to secure the achieved reduction.

The first K wire was passed from tip of lateral epicondyle at an angle of 45°–50° directing superiorly and medially in the AP view of image intensifier. After advancing few millimeters starting from the lateral cortex, the wire position was checked in the lateral view, to confirm its position in the center of humerus. The wire was then advanced above the olecranon fossa up to medial cortex in standard fashion. The second K wire was introduced exactly parallel and one cm inferior to the first wire and, it was confirmed that this wire passes through lateral cortex, two walls of olecranon fossa, and medial cortex in proximal fragment (four cortices in total), so we call it Trans olecranon fossa four cortex purchase (TOF-FCP) technique.

This second K wire gets started close to the capitellum of involved elbow. Third wire and fourth were added wherever needed, with the same technique, either between the previously placed two wires, or below the second wire. After adequate fixation from minimum of two pins (six cortices purchase) to maximum of three pins (ten cortices purchase), strapping was removed. The elbow was rotated and stability was confirmed. The K wires were bent and cut outside the skin leaving one centimeter, antiseptic dressing done. A well padded above elbow was applied with elbow in 90° of flexion as tolerated. Immediately in the postoperative period after recovery from the anesthesia effect, the neurovascular status of the limb was assessed, for postoperative analgesia and prevent infection, syrup ibuprofen and syrup cefixime according to weight of patients, were given for 3 days. Radiographs of the operated elbow were taken before discharge and assessed for quality of reduction

by baumann's angle. The children were discharged from the hospital after two days of surgery. The children were kept under weekly follow-up for pin tract assessment and plaster care for one month. Radiographs were taken after 4 weeks in children to assess the fracture healing. After radiological union, wires were removed as an outpatient procedure. Child was encouraged for gradual mobilization exercises and physiotherapy was advised, till elbow full range of movement was regained. Carrying angle was measured using goniometer once the patient achieved full elbow extension. The baumann's angle was measured from the radiographs taken at that time.

Result: Among 39 patients, 30 were male and 9 were female. The fracture was extension type in all 39 patients. Left side was involved in 22 patients and right side in 17 cases. The average age was 6.1 yrs. Based on Gartland classification 16 patients had type-II and 23 patients had type III pattern. Minimal complications were noted in our study. As per Flynn Criteria 33 were excellent, 6 Good, 1 was fair. None had post-operative neurovascular compromise. Union was achieved without any serious complication. Patients with pre-manipulation nerve deficit recovered fully.

Table 1:Flynn's Criteria

Results	Rating	Loss of carrying angle loss of motion
Satisfactory	Excellent	00-50 00-50
	Good	50-100 50-100
	Fair	100-150 100-150
Unsatisfactory	Poor	>150>150

Table 2:Age group wise distribution of the study

Frequency	Percent
1-5	1743.6
5-10	2051.3
>10	25.1
Total	39100.0

Mean \pm SD 6.41 \pm 2.33 3-13 range

Table 3: Gender wise distribution of the study

Frequency	Percent
F	923.1
M	3076.9
Total	39100.0

Table 4 : Side wise distribution of the study

Frequency	Percent
Right	1743.6
Left	2256.4
Total	39100.0

Table 5: Type of fracture wise distribution of the study

Gartland's fracture type	Frequency Percent
Type 1	216 41.0
Type 2	323 59.0
Total	39100.0

Table 6: Displacement wise distribution of the study

Frequency	Percent
POSTEROLATERAL	417.4
POSTEROMEDIAL	1982.6
Total	23100.0

Table 7: Baumann Angle wise distribution of the study

Name	Mean	Std. Deviation Minimum	Maximum P value
Normal Limb	72.490	3.1280 680	780 810 0.07 810
Injured Limb Post reduction	76.180	2.7710 700	
Injured Limb Post union	76.180	2.7710 700	

Table 8: Carrying Angle wise distribution of the study

Name	Mean	Std. Deviation	Minimum	Maximum	P value
Normal Limb	11.620	1.8720	80	150	0.001(S)
Injured Limb Post union	8.670	2.0560	50	130	

Table 9: Range of Flexion wise distribution of the study

Name	Mean	Std. Deviation	Minimum	Maximum	P value
Normal Limb	139.510	3.8310	1300	1450	0.001(S)
Injured Limb Post union	134.870	3.9620	1240	1420	

Table 10: Range of Extension wise distribution of the study

Name	Mean	Std. Deviation	Minimum	Maximum	P value
Normal Limb	6.720	1.5380	40	100	0.001(S)

Injured Limb Post union	8.380	2.6320	50	120	
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Table 11 : Flynn criteria wise distribution of the study

Frequency	Percent
Excellent	3384.6
Good	512.8
Fair	12.6
Total	39100.0

Discussion : The treatment of supracondylar fracture of Humerus in children is quiet challenging. These fractures are very common in children between 5 to 10 years of age as reported in studies by Ziontes LE et al. [14] In the present study, the average age was 6.1 years similar to other studies. The incidence of this type of fracture is reported to be more in boys than girls. In the present study, 30(76.9%) were male patients and 9 (23.1%) were female. Supracondylar fractures result from a fall on an outstretched hand in up to 70% of patients [15] . The non-dominant extremity was most commonly affected. In the present study, 22 (56.4 %) had left sided injury and 9 (28.13%) of them had right sided injury. Based on Gartland's classification, 16(41%) patients had Type II fracture and 23(59%) had Type III fracture.. Skaggs D et al. studied consequences of pin placement in operative treatment of supracondylar fracture of Humerus in children and concluded that fixation with only lateral pins was safe and effective for both Gartland type II and type III fractures, moreover it prevented iatrogenic injury to ulnar nerve. They did not recommend routine use of crossed pins and if at all medial pin was used, the elbow should not be hyper flexed during its insertion [16] . Boyd et al. preferred crossed medial and lateral pins and reported that out of 71 patients, 70 cases had satisfactory result and only 1 case had ulnar nerve palsy. Ziontes et al. studied torsional strength of various pin configurations and concluded that two crossed pins provided maximum resistance against rotational displacement, followed by 3 lateral pins and 2 lateral pins. Ring D et al. found two cases with compartment syndrome following closed reduction and cast immobilization [17] .None of our patients developed any complication like iatrogenic ulnar nerve injury,elbow stiffness. As per Flynn Criteria 33 were excellent, 6 Good, 1 were fair. Our results match with Williamson DM et al. who managed the supracondylar fracture by traction, manipulation, reduction and percutaneous pinning (PCP) [18] and with Harrington P et al. who observed 83% good to excellent results [19] . The incidence of deep infection and osteomyelitis was very low as reported by Mostafavi HR et al. and Gupta N et al. [20, 21] Supracondylar humerus fractures are the most common elbow fracture in a pediatric population [22, 23] . Several complications have been associated with the management of these injuries. LOR may occur and has ranged in the literature from 0.7% to 15% [24, 25] . A recent meta-analysis of at least 10 studies had an overall rate of 4% for lateral entry-pin constructs and 2% for cross-pin constructs. Although these numbers may vary in the literature in part due to how LOR is defined, they are in line with our reported rate of 15.63%.

Conclusion: According to our study, if a uniform standardized operative technique is followed in method, then the TOF-FCP of percutaneous fixation method will be safe and effective. The selection of fixation method rests on the surgeon's

preference and his confidence and familiarity with the method. The TOF-FCP pinning does have lower rate of complications according to our study, this technique has given excellent results in majority of cases of unstable SCFH. In our study none of the patients found any complication of iatrogenic nerve injury, elbow stiffness. This technique promises stable fixation in comminuted and unstable fracture patterns without loss of reduction.

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