ORIGINAL ARTICLE

A COMPARATIVE STUDY OF OUTCOMES OF PERCUTANEOUS CROSSED VS LATERAL DIVERGENT PINNING IN THE TREATMENT OF DISPLACED (GRADE-3) SUPRACONDYLAR FRACTURES OF HUMERUS IN CHILDREN

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ABSTRACT: INTRODUCTION: Displaced supracondylar fractures of humerus are one of the most common fractures in paediatric age group with preferred treatment being close reduction with percutaneous k-wire fixation. This study compares whether lateral pin construct alone can provide same stability like medial and lateral pin fixation, and prevent iatrogenic ulnar nerve injury. **MATERIAL & METHODS:** This is a prospective comparative randomized controlled trial. A total of 60 patients of displaced supracondylar fracture aged between 3-12 years with fresh fracture, without any compound injury or communition were enrolled for the study and randomly divided into two groups, A and B. For each group of 30 patients, they were assigned treatment of crossed pinning and lateral pinning respectively and outcome was evaluated on basis of pain, motion, stability and function according to Mayo's elbow score and follow-up was maintained for a period of 45 days and test for statistical significance were applied. **RESULTS:** After assessing 30 patients in each group we found out that mean mayo score was 98 in cross pinning group and 96.83 in lateral pinning group. This difference is statistically not significant. (p value - 0.502). **CONCLUSION:** In our study we conclude that, Lateral pinning is an equally good treatment choice in these fractures and especially for grossly swollen elbows in which medial epicondyle is barely palpable with increased risk of ulnar nerve injury during placement of medial pin. Both the methods offer consistently satisfactory functional and cosmetic results.

KEYWORDS: Displaced supracondylar fractures of humerus, percutaneous cross and lateral pinning, MAYO'S elbow score.

INTRODUCTION: Supracondylar fractures of humerus comprise about 17 percent of all childhood fractures. The treatment of supracondylar humeral fractures in children has been the subject of much discussion and dispute for many years. Historically, these fractures were associated with complications such as mal-union that resulted in cosmetically and functionally inferior results. Results have been improved and frequency of these complications dramatically decreased with more modern techniques of treatment.

Treatment of supracondylar fracture has included closed reduction and casting in hyper-flexion, traction, open reduction with pinning and closed reduction with pinning. The goal of all forms of treatment is the same, to obtain and maintain an anatomical reduction of the distal

humerus to minimize complications such as nerve injury, compartment syndrome, volkmann ischaemic contracture, cubitus varus deformity and limitation of elbow movements.

The non-operative management of displaced 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 the fracture reduction and subsequent complications as compared with surgical line of treatment.

The high rate of complications associated with non-operative treatment lead to the evolution of current techniques of per-cutaneous pinning for these difficult fractures over the past three decades. Standardization of surgical techniques for performing pin fixation with radiographic control has markedly reduced the incidence of poor outcomes. The advantages of per-cutaneous pinning methods include easier management of extensively swollen elbows, better maintenance of reduction and decreased risk of associated complications.

The present study is an attempt towards assessing and comparing the results of two methods of pinning – crossed pinning and lateral divergent pinning - presently followed in the management of these difficult fractures.[1,2]

AIM: To Compare The Results Of Displaced [Grade-3] Supracondylar Humerus Fractures Treated With Percutaneous Crossed Pinning And With Two Lateral Divergent Pinning.

OBJECTIVES: To Assess The Outcome Of Treatment Of Displaced [Grade-3] Supracondylar Fractures By Closed Reduction With Percutaneous Crossed Pinning and Percutaneous Lateral Divergent Pinning.

MATERIAL AND METHOD: It is a prospective comparative study. We have studied 60 cases with displaced [grade-3] supracondylar humerus fracture treated with percutaneous crossed pinning and lateral divergent pinning. 30 cases treated with crossed pinning and 30 cases treated with lateral divergent pinning.

Cases age between 3 to 12 years with fresh fracture presented with in 0-4 days without previous fracture in same elbow were included in the study.

Cases with undisplaced [Grade-1 & 2] supracondylar fractures; compound fracture; comminuted fracture; fracture associated with compartment syndrome; fracture requiring open reduction; Isolated medial or lateral epicondyle fracture; floating elbow; fracture with neurovascular Injuries were excluded.

Immediately after the patient's arrival to the hospital a detailed clinical examination including a thorough neurovascular assessment was carried out. Standard antero-posterior and lateral radiographs of the involved elbow were taken and the fracture type was noted. The cases were treated on an emergency basis with closed reduction and per cutaneous pinning, under the guidance of C-arm image intensifier. General anaesthesia was employed for all cases. The patient was positioned supine on the operating table with affected limb being placed on a side table or over the sterile draped C-arm image intensifier. Then a step-wise closed manipulation was performed. Assessment of reduction was done under image intensifier by taking anteroposterior and lateral views; lateral view was taken by external rotation of shoulder. Maintenance of

reduction was achieved by passing two crossed K-wires from both the medial and the lateral epicondyles or by passing two K-wires from the lateral condyle in a divergent fashion. When crossed pinning was employed, the lateral pin was inserted first so that the medial pin can be placed with the elbow in less flexion to avoid ulnar nerve injury. The choice of crossed or lateral pin fixation was made according to the operating surgeon's personal preference. Once the pins were in place, the elbow was extended and the adequacy of reduction was assessed with AP and lateral images.

After leaving about 1cm of the pins outside the skin, pins were bent and cut off and well - padded posterior above elbow slab was applied with elbow flexed to 90 degrees or less as tolerated. Immediately in the postoperative period, the neurovascular status of the limb was assessed. The 'K' wires were removed at the end of four weeks-time as an outpatient procedure. The slab was continued till the end of 6th week. Active elbow exercises were started from fourth week as tolerated by the child. Passive motion and forceful manipulation were avoided. Follow up after operation was done regularly at end of 15th Day, 28th Day & 45th Day. During first three follow-up pain, displacement and any complications were assessed. After removal of pins at the end of four weeks active flexion and extension were started. At the end of 6th week pain, range of flexion and extension [range of motion] were measured and function of operated extremity was assessed. A neurological examination was performed to note recovery in case of iatrogenic nerve injuries; starting post operatively and at regular interval of 15 days till patient recovered. Follow-up X-rays were done post operatively; first immediate after operation, at the end of 15th Day, 28th Day & 45th Day to note any displacement, mal-alignment and fracture union.

Finally, the functional outcome was assessed on the basis of Mayo 's elbow score.[3]

Mayo Elbow Performance Score

Function	Points	Definition (Points)
Pain	45	None (45) Mild (30) Moderate (15) Severe (0)
Motion	20	Arc >100 degrees (20) Arc 50–100 degrees (15) Arc <50 degrees (5)
Stability	10	Stable (10) Moderate instability (5) Gross instability (0)
Function	25	Comb hair (5) Feed (5) Perform hygiene (5) Don shirt (5) Don shoe (5)
Total	100	

Classification: excellent, >90; good, 75–89; fair, 60–74; poor, <60.

The outcome was considered excellent, when the Mayo's score is >90 which includes no pain, motion >100, absolute stability and patient could perform all activities which are given in mayo's score system. Results were graded as good, fair and poor when the mayo's score is between 75-90, 60-74 and < 60 respectively. Statistical analysis was done by Chi-square test and t-test.

RESULTS AND ANALYSIS: The Mean Age of Patients was 7.48 Years. The Incidence in Male children (40 cases) was double as compare to female (20 cases) that was 66.6%.

	FREQ	PERC
LT	38	63.33%
RT	22	36.66%
TOTAL	**60**	**100.00%**

Table 1: Side involved

Left Side was involved in 63.33% that was double as compare to right side. 75% Cases had posteromedial displacement of distal fragment that was three times more common than posterolateral displacement.

Mean Duration of follow up was 43.7 days. Incidences of Pin tract Infection were 10.00% in cross pinning & 16.66% in lateral pinning. (X^2= 0.5172; p Value = 0.4720).

	>100		< 100	
	FREQ	%	FREQ	%
CP	27	90.00	3	10.00
LP	25	83.33	5	16.66

Table 2: Range Of Motion

In cross pinning 90% and in lateral pinning 83.33% cases had more than 100 degrees of range of motion.

	TYPE OF PINNING				TOTAL
	CROSS		LATERAL		
	CASES	%	CASES	%	
EXCELLENT	27	90.00%	25	83.33%	52
GOOD	3	10.00%	5	16.66%	8
TOTAL	30	100.00%	30	100.00%	60

Table 3: Type of pinning v/s outcome

p Value = 0.7041; X^2 Value= 0.1442.

There were 90% Excellent and 10% Good Results In CROSS PINNING Group & 83.33 % Excellent and 16.66% Good Results in LATERAL PINNING Group.

The difference in functional outcome between two groups was not statistically significant.

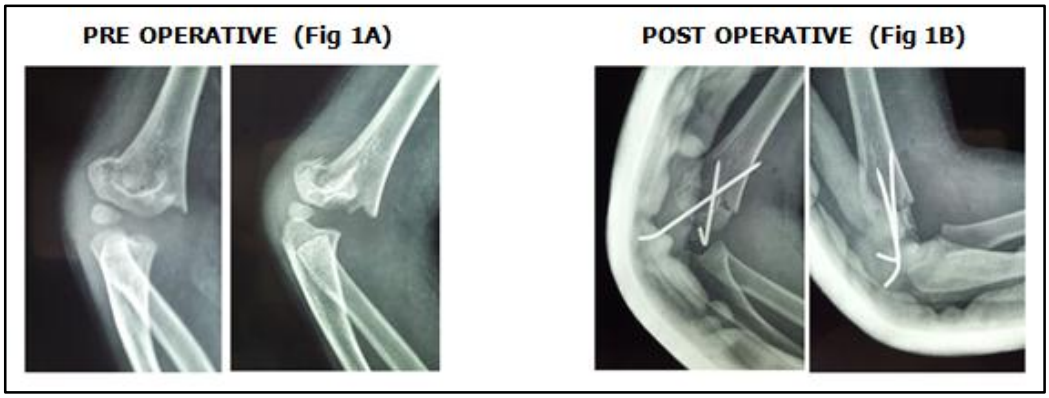
	SCORE	SD	T VAL	P VALUE
CP	98	6.103	0.6743	0.5028
LP	96.83	7.250		

Table 4: Comparison of Mayo score

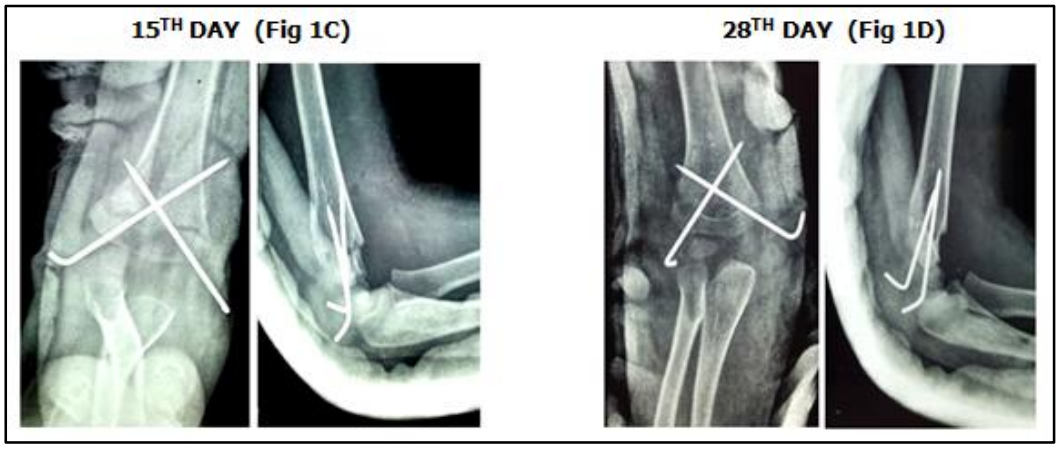
Mean MAYO's Elbow Score in CROSS PINNING was 98 & Mean MAYO's Elbow Score in LATERAL PINNING was 96.83.

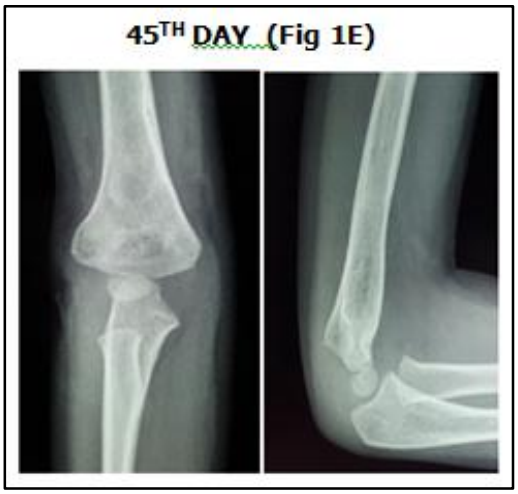
The Difference between two groups was statistically Non- Significant.

CASE I - CROSS PINNING (FIGURE 1):

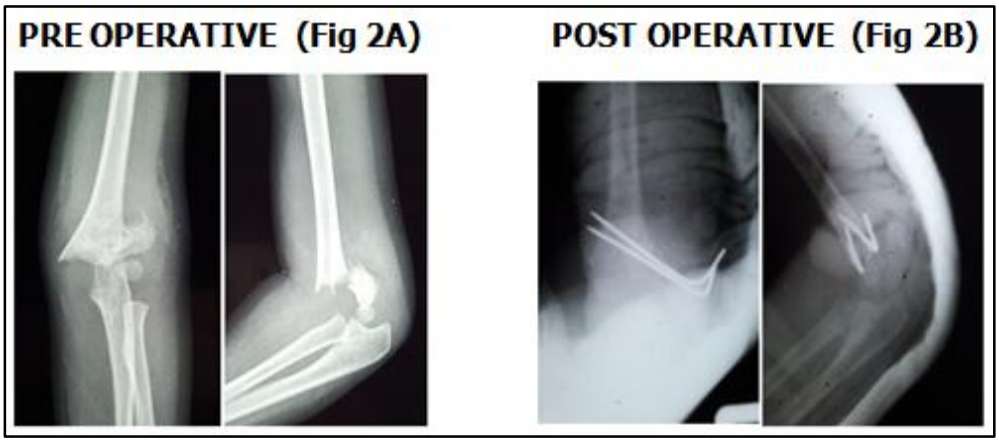


FOLLOW UP X-RAYS:

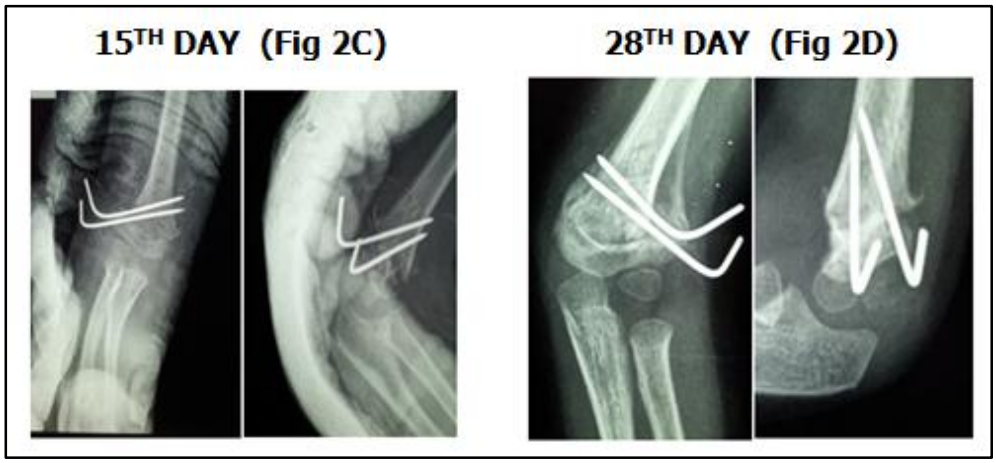


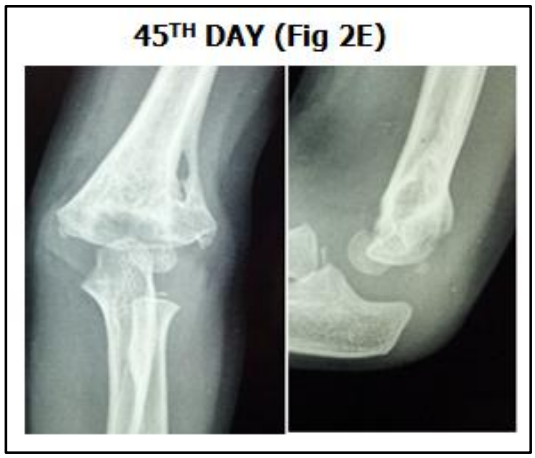


CASE II – Lateral Pinning (Figure 2):



FOLLOW UP X-RAYS:





DISCUSSION: In this study, sixty children with displaced [Grade-3] supracondylar fractures of humerus who were treated with closed reduction and percutaneous crossed pinning (medial-lateral) or divergent lateral pinning methods were evaluated prospectively. The age group of patients considered was between 3 to 12 years. The peak incidence was in 6-8 years age group with an average age of 7.48 years.

This was similar to series by Wilkins[4] with a peak incidence of 5-8 years and an average age of 6.7years. In our series, incidence in male children was 66.60% and 33.40% in females. This male preponderance was also noted in the series of Wilkins[4] (males 62.85%) and of Solak[5] (males 72.8%). The left side was involved 2 times (63.33% of cases) more commonly than the right in our study, which is comparable to that of Aronson and Prager[6] (2 times). The common mechanism of injury in our series was fall on an outstretched hand (96%) which is same as that in series by Mostafavi.[7] In our series, there was 75% incidence of postero-medial displacements and 25% postero-lateral displacements. The other series also showed higher rate of postero-medial displacement: Wilkins[4] (75%), Aronson and Prager[6] (75%) and Mostafavi[7] (82%). The incidence of pre-operative nerve injuries was not recorded in our study. Radial pulsation was weak in 26 cases in our series but peripheral circulation was intact in all of them with normal dynamic functions of hand. Oxygen saturation levels at the periphery were noted to be satisfactory in these cases. Cases with postero-lateral displacement had more incidence of weak radial pulse (80%) as compared to cases with postero-medial displacement (51%). These cases were kept under constant observation with frequent neurovascular assessment. All cases regained normal radial pulsation within 24-36 hours following reduction of fracture and per-cutaneous pinnings. Fowles and Kasaab[8] had similar findings in their series. The average hospital stay for a patient in our study was 4 days with a range of 1 to 7 days. The average hospital stay in other series was 3.4 days by Aronson and Prager[6] and 4.2 days by Nacht et al[9]. All the cases presented with displaced grade-3 supracondylar humerus fractures were fixed as an emergency procedure as early as possible as patient arrived to hospital. The follow-up period for cases ranged from 7 days to 45 days with an average follow up duration of 43.78 days. The minimum duration of 40-42 days of follow up in our series was adequate to assess stability; fracture union and range of motion. In our series, a total of 60 cases were treated; 30 patients (50%) underwent crossed pinning with medial and lateral pins and 30 patients (50%) underwent lateral

pinning in divergent fashion. The choice of method of pin fixation was made according to operating surgeon's personal preference.

Pin tract infection with pin loosening occurred in 8 patients in our series (13.33%). Out of these eight cases three were operated with the crossed pinning and five were treated with lateral pinning. In the series by Mostafavi[7], the incidence of pin tract infection was 5%. Pin tract infection with pin loosening, necessitated earlier removal of 'K' wires (at 3 weeks). The infection was treated with appropriate antibiotics and regular wound dressing. The above elbow slab was continued in these patients. Infection was fully eradicated in all 8 patients with the above measures. Out of these eight patients seven patients had loss of range of motion about 15 to 20 degrees compare to those without infection and one case with pin tract infection had more than 100 degrees of range of motion.

There were no iatrogenic nerve injuries following both types of fixations. All patients achieved radiological union at an average of 5.2 weeks. This compared favorably with the series by Mostafavi[7] where union occurred at an average of 7.2 weeks. In our study at the end of operation and at the end of average 4-5 weeks stability was same for both crossed and lateral pinning. Series by Skaggs et al[10] demonstrated no clinical difference in stability between crossed and lateral pins. The correlation between the type of pinning and functional outcome was made on the basis of pain; stability and range of motion and back to daily routine activities as per MAYO'S SCORE system.

The mean score of cross pinning group was found to be 98. The mean score of lateral pinning group was 96.8. Though the value of cross pinning group was slightly higher than the lateral pinning group, there was no statistical difference between the mean functional scores in both groups. In our series, the functional outcome following crossed medial – lateral pinning was excellent in 90% and good in 10% of cases. There were no poor results. This compared favourably with the series by Mostafavi[7] with 88% excellent results. In our series cases treated with lateral pinning showed 83.33% excellent and 16.66% good results with no poor results. In the series by Aronson and Prager[6] excellent results were found in 88% and good results in 12%. The difference in functional outcome between two groups was not statistically significant [X^2-0.1442; p value-0.7041].

CONCLUSION: In our study, we observed that close reduction and percutaneous pinning is an excellent method of treatment of displaced [Grade-3] supracondylar humerus fractures in children. There was no significant difference between the functional outcomes of both the treatment modalities, which was measured by Mayo's elbow score.

We observed that pain was there for initial two week in any type of fixation but more in lateral type of pinning and especially with pin tract infection.

There was no difference in stability in any type of fixation throughout our study. There was no extreme difference in loss of range of motion in both type of fixation, but three cases fixed with crossed pinning had loss of 15-20 degrees of flexion and five cases fixed with lateral divergent pinning also had loss of 15-20 degrees of flexion then the normal 100 or more degrees of flexion achieved by all other cases. There were eight cases of pin tract infections noted in our study but all recovered well with antibiotics and regular dressings, other early complications like

iatrogenic vascular injuries, compartment syndrome, myositis ossificans, loss of reduction and implant failure were not noted in our study. Later complications like cubitus varus, hyperextension were eliminated as our study was for short time period up to 45 days.

So we conclude that crossed medial and lateral pinning is the treatment of choice in these fractures, with careful technique which safeguards the ulnar nerve. We also observed that lateral pinning is an equally good treatment choice especially for the grossly swollen elbows in which the medial epicondyle in barely palpable with increased risk of ulnar nerve injury during the placement of medial pin. Both the methods offer consistently satisfactory functional and cosmetic results.

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