International Journal of Research in Orthopaedics
Paramasivam D et al. Int J Res Orthop. 2022 Jul;8(4):463-469
http://www.ijoro.org

DOI: https://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20221623

Original Research Article

Outcome analysis of cross-pinning versus lateral pinning and various lateral pinning configuration in the treatment of displaced paediatric supracondylar humerus fracture

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Received: 20 April 2022
Accepted: 16 May 2022

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ABSTRACT

Background: Supracondylar humerus fracture accounts for 3% of all the paediatric fractures. Displaced fractures need usually closed but rarely open reduction and stabilization with k-wires by either cross or lateral pinning technique. Controversies prevail regarding the type of pinning which will reduce complications (such as ulnar nerve palsy and loss of reduction which will lead to cubitus varus deformity) and provides better functional and radiological outcome. The aim of study was to analyse outcomes of various pinning techniques in displaced supracondylar humerus fracture treatment.
Methods: This was a prospective study done in SRIHER, Chennai (January 2019 to September 2020) included children with displaced supracondylar humerus fracture (modified Gartland type 2B,3). Preop, postop and intraop assessment were done with respect to incidence of ulnar nerve palsy, Baumann's angle, Flynn criteria till 14 weeks postop period. The results of cross pinning and lateral pinning group were statistically compared.
Results: There were totally 37 (male-25, female-12) patients. Mean age was 5.6. The mean change in Baumann's angle of cross pin and lateral pin group at 14 weeks postop period comparing immediate postop period were 4.13 and 4.15 degrees, which was statistically insignificant using Mann Whitney test ($p>0.05$). Flynn criteria at 14 weeks postop period between two groups were also statistically insignificant. Difference in Baumann's angle at 14 weeks postop period between divergent (2.82) and parallel (5.53) pin group was statistically significant using Mann Whitney test (0.01). There were no cases of ulnar nerve injury in both the groups.
Conclusions: Lateral pinning technique with the use of 3 divergent pins for the treatment of displaced supracondylar humerus fracture gives stability as good as cross pin configuration and also avoids the risk of ulnar nerve injury.

Keywords: Lateral pin, Cross pin, Supracondylar fracture, Paediatrics

INTRODUCTION

Supracondylar fracture of humerus is the most common fracture in children. It accounts for 3% of all the paediatric fractures. 90% of fracture are extension type and 10% of fractures are flexion type or complex intercondylar fractures. Mode of injury-fall with outstretched hand in children that leads to hyperextension of the elbow, here the fulcrum is the olecranon which transmits the stress over distal humerus (supracondylar area), predisposing the distal humerus fracture. In 1959, Gartland described a simple classification system which emphasized the principles of treatment of supracondylar fracture of humerus in children that has proven to be practical also effective with time.[1] The classifications used for supracondylar fracture of humerus in children are Gartland

classification, Wilkins modified Gartland classification and Lagrange and Rigault classification, AO classification. Undisplaced fractures especially Wilkins modified Gartland type I and type IIA fractures are usually treated conservatively using posterior Splint with elbow in flexion.[2,3] Shoaib et al had shown the satisfactory results for conservative management in type IIA fracture but unsatisfactory in displaced supracondylar humerus fracture, type IIA, type III.[4] Displaced fractures needs usually closed but rarely open reduction and stabilization with Kirschner wires and Splinting to prevent complications such as non-union and cubitus varus deformity. Kirschner wires can be applied in various configurations to stabilize the fracture which is reduced. The configurations are the cross pinning and the lateral pinning. Cross pinning is the commonly done technique in the past decade which includes insertion of one pin medially and one pin laterally through the corresponding epicondyles. Complication such as Ulnar nerve injury that needs careful ulnar nerve isolation during medial pinning is the potential problem and that needs expertisation. Also ulnar nerve isolation needs skin incision that poses cosmetic disadvantage. To overcome this complication the technique of closed reduction and lateral pinning with pop application has been done in recent days. But it is proposed that there is loss of reduction in lateral pin configuration when compared to cross pin configuration. Controversies prevail regarding the type of pinning which will reduce these complications and provides better functional and radiological outcome. The aim of the study was to compare and analyse the outcome of various pinning techniques employed in displaced paediatric supracondylar humerus fracture treatment.

METHODS

This was a nonrandomized prospective study done in Sri Ramachandra Institute of Higher Education and Research. Study period was 18 months (January 2019 to December 2020).

Inclusion criteria

The inclusion criteria were age 3 to 13 years including both male and female; closed isolated supracondylar fracture of humerus with A) Wilkins modified Gartland type IIB and type III fracture.

Exclusion criteria

The exclusions were pathological fractures, compound fractures, patients with head injury, claw hand deformity, Erb's palsy, Gartland type I and IIA fractures.

Children were selected for study based on inclusion and exclusion criteria. Informed consent was obtained from parents/guardians. Assent consent was taken for each patient. Detailed history was noted. As preoperative assessment-radial pulse of the injured upper limb of the patients was assessed on arrival, ulnar nerve sensation assessed over medial one and half fingers (palmar and dorsal surface), by finger touch sensation. Anteroposterior and lateral radiographs of injured elbow was taken and Posterior splint was applied for the immobilization till surgery. Fracture was classified according to Wilkins modified Gartland classification.[5] For all the study population, general anaesthesia was used. Position was supine. Fracture was reduced (closed) by traction and counter traction method using c-arm. Then correction of mediolateral displacement was done. Then the extension deformity was corrected by hyperflexion of elbow beyond 100 degree having maintaining pressure over olecranon by the surgeon. Inability to hyperflex beyond 100 degree indicates soft tissue entrapment which was corrected by milking method. The adequacy of reduction was confirmed by Roger's line in intraoperative c-arm true lateral view of elbow for all the patients. Type of pinning was the surgeon preference. 1.6 mm K-wire was used for younger children and 2 mm K-wire was used for older children. In case of cross pinning-one or two medial and one or two lateral pins was used depending upon surgeon preference. In case of lateral pinning-2 or more parallel/divergent pins with opposite cortex purchase was used depending on surgeon preference. Lateral wires were passed percutaneously. Medial wires were inserted through mini open approach. Skin incision was made to visualize directly the medial epicondyle and wires were inserted preventing ulnar nerve entrapment. Type of pinning and number of pins used were noted. Above elbow back slab was applied with elbow in 80-90 degree flexion having confirmed the presence of radial pulse. Broad spectrum antibitotic was given preoperatively 1 dose and postoperatively 2 doses. Postoperative assessment was done as follows. On immediate post period: functional assessment was done by examination of ulnar nerve as follows- sensory-by assessing sensation over medial 1 and half finger of the patient was done by examiner' s finger touch sensation, motor-by asking abduction and adduction of fingers of the operated limb of the patient; radiological assessment was done using Baumann angle (BA) measured (using IC measure) in the anteroposterior radiograph of elbow done on postop day 1 or 2 depending on pain tolerance of the patient. At 6 weeks postoperative period radiological assessment was done using Baumann angle measured in the Anteroposterior radiograph of elbow. Under general anaesthesia, K-wires was removed and active elbow mobilisation was started. At 8 weeks,10 weeks and 14 weeks post-operative period, functional assessment was done using Flynn criteria and radiological assessment was done using Baumann angle in anteroposterior radiograph of the elbow.[6] The overall results were interpreted using statistical methods.

The collected data were analyzed with IBM Statistical package for social sciences (SPSS) Statistics software 23.0 version. After dividing the data collected into quantitative and qualitative variables, the data was analyzed using frequency analysis, percentage analysis, mean, SD, Mann Whitney U test, Chi square test. Using statistical tool, the probability $p<0.05$ was considered as significant. $P<0.05$

was considered as significant and p<0.01 was considered as highly significant.

RESULTS

There were totally 37 patients in which 25 patients were males and 12 patients were females. Majority of study population were in age group between 3-6. Mean age of the study participants who underwent lateral pin fixation was 6.10 and cross pin fixation was 5.63. 66.7% of the participants who underwent lateral pin fixation were males and 33.3% were females. 68% of the participants of who underwent cross pin fixation were males and 31.2% were females. Majority of the study participants in both lateral and cross pin fixation group sustained modified Gartland type 3 fracture, 71% in lateral pin fixation group and 68.8% in cross pin fixation were sustained type 3 fracture. 28.6% in lateral pinning and 31.2% in cross pinning were sustained modified Gartland type 2 fracture. All the patients underwent closed reduction. There was no need for open reduction in any of the case.

Table 1: Comparison of postop differences such as BA and loss of motion (LOM) between lateral and cross pin fixation at immediate postop, 6 weeks postop, 8 weeks postop and 14 weeks postop.

Comparison	Lateral pin Mean (SD) N (%)	Cross pin Mean (SD) N (%)	P value
Immediate post op			
BA	70.98 (3.73)	68.92 (2.05)	0.14
6 weeks			
BA	72.12 (3.62)	70.24 (2.58)	0.13
8 weeks			
LOM	30.00 (5.0)	35.63 (6.29)	0.008
10 weeks			
LOM	17.62 (6.24)	27.50 (5.16)	<0.001
BA	73.82 (3.78)	71.04 (2.25)	0.23
14 weeks			
LOM	4.52 (4.4)	6.31 (4.4)	0.26
BA	75.13 (3.82)	73.05 (2.49)	0.15

Table 2: Comparison of lateral and parallel pin fixation with respect to Flynn grade at the end of 14 weeks.

Pin group	Excellent/good N (%)	Fair N (%)	Total N (%)	P value
Lateral pin	17 (58.6)	4 (50.0)	21 (56.8)	
Cross pin	12 (41.4)	4 (50.0)	16 (43.2)	0.705
Total	29 (100)	8 (100)	37 (100)	

Among the participants who underwent lateral pin fixation, 57.1% had 2 pin fixations while 42.9% had 3 pin fixations. Among the lateral pin fixation, 57.1% of the participants had divergent pin fixation and 42.9% of the participants had parallel pin fixation. Immediate post op mean BA among the lateral pin fixation participants were 70.98 (3.73), at 6 weeks the mean and standard deviation of BA were 72.12 and 3.62 respectively. And the mean and standard deviation of BA at 10 weeks and 14 weeks were 73.82 (3.78) and 75.13 (3.82) respectively. Similarly, the mean and standard deviation of Loss of Motion (LOM) at 8 weeks, 10 weeks and 14 weeks were 30.0 (5.0), 17.62 (6.24), 4.52 (4.4) respectively.

Immediate postop mean of BA among the cross pin fixation participants were 68.92 (2.05), at 6 weeks the mean and standard deviation of BA were 70.24 and 2.58 respectively. And the mean and standard deviation of BA at 10 weeks and 14 weeks were 71.04 (2.25) and 73.05 (2.49) respectively. Similarly, the mean and standard deviation of LOM at 8 weeks, 10 weeks and 14 weeks were 35.63 (6.29), 27.50 (5.16), 6.31 (4.4) respectively.

The difference between the mean BA, LOM, among the lateral and cross pin fixations at immediate postop, 6 weeks,8 weeks,10 weeks and 14 weeks postop period is given in the Table 1, Figure 1 (Differences in BA), Figure 2 (Differences in LOM). There was no statistically significant difference in the BA between lateral and cross pin fixation at immediate postop period, 6 weeks, 10 weeks and 14 weeks (using Mann Whitney U test, p>0.05). With respect to LOM, the difference between lateral and cross pin fixation is significant at 8 and 10 weeks but there is no significant difference in LOM between lateral and cross pin fixation at 14 weeks (p=0.26).

58.6% of excellent to good score according to Flynn criteria was achieved by participants of lateral pin fixation

and 41.1% was achieved by cross pin fixation but this difference is not statistically significant (using chi square test) (Figure 3, Table 2). The difference in BA from immediate postop to 6 weeks and 10 weeks after surgery among divergent and parallel pin fixation showed no statistical significance. But the difference in BA at 14 weeks postop showed significant difference between divergent and parallel pin fixation where mean of difference of BA of divergent pin fixation (Mean=2.82) showed least change compared to parallel pin fixation (Mean=5.53) (Table 3, Figure 4). At the end of 14 weeks change with respect to BA comparing immediate post op among 3 lateral pin and 2 lateral pin group showed 3 pin group had least change in Baumann angle of 2.75 degrees whereas 2 pin group had change of 4.9 degrees (Table 4). This shows that using 3 lateral pins confers better stability. There were no case of post operative ulnar nerve palsy and infection.

Table 3: Difference in BA among divergent and parallel pin fixation in lateral pin fixation groups.

Number of pins	Difference in BA	P value
2	4.90	0.02
3	2.75	

Table 4: Comparison of difference in BA from immediate post op to 14 weeks after surgery among number of pins in lateral fixation group.

Comparison	Divergent Mean (SD)	Parallel Mean (SD)	P value
Immediate post op to 6 weeks	1.23 (0.47)	1.09 (0.62)	0.46
Immediate post op to 10 weeks	2.13 (1.07)	3.77 (2.50)	0.58
Immediate post op to 14 weeks	2.82 (1.71)	5.53 (2.83)	0.01*

Figure 1: Positioning, reduction and pinning.

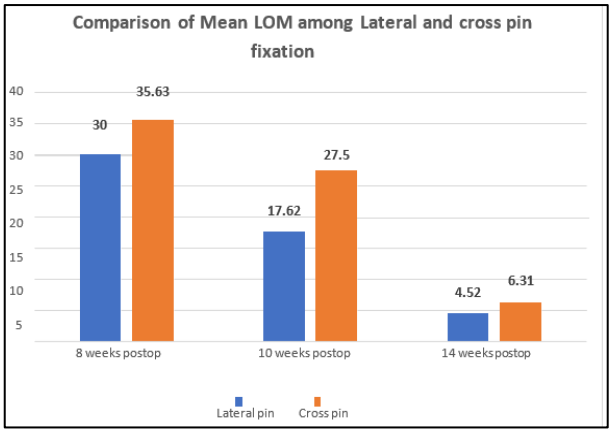

Figure 2: Comparison of mean loss of motion among lateral and cross pin fixation at 8 weeks, 10 weeks and 14 weeks.

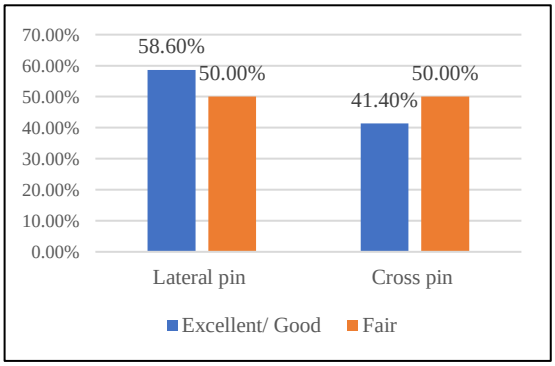

Figure 4: Comparison of Flynn grade among lateral and cross pin fixation at 14 weeks.

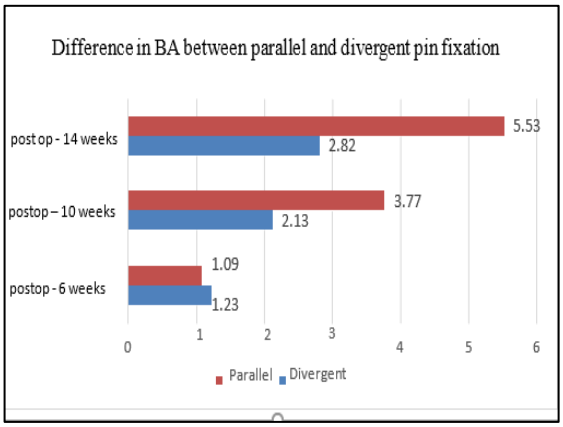

Figure 5: Difference in BA from immediate postop among pin types of lateral pin fixation.

DISCUSSION

The standard treatment for the displaced i.e Wilkins modified Gartland type IIB and type III supracondylar humerus fracture in children is the closed reduction with K- wire fixation. Kinkpe et al and Muccioli et al have demonstrated the good results in supracondylar type 2 and 3 fracture using Blounts method which was described in

1954 and is a conservative treatment method.[7,8] But there was no adequate support of literature to use Blount's method in routine day to day practice and it cannot be applied for the fracture which were highly unstable having torn periosteum and the vascular compromise. The two pinning techniques available were the cross pinning and the lateral pinning technique. The cross pinning technique provided the better stability but there was a risk of ulnar nerve injury as per literature. In hands of less experienced surgeons, the risk of ulnar nerve injury was always the nightmare and hence the procedure was technically demanding. In other context lateral pinning posed the fear of loss of stability which will lead to the cubitus varus deformity.

Behdad et al in his study about paediatric elbow fracture, distribution had shown that mean age for commonest elbow fracture, supracondylar humerus fracture was 8.1 and boys were injured almost 2.6 times more than girls.[9] In our study the mean age was 5.6 and boys were more injured almost 2 times than girls. Lee et al have studied the efficacy of using divergent pins in the management of displaced supracondylar fractures.[10] In their study, 61% of the participants had sustained type 3 gartland fracture and 39% had sustained type 2 gartland fracture. They have shown no patients had loss of reduction with the usage of divergent pins. In our study also majority of participants 70.3% had sustained type 3 gartland fracture and only 29.07% of patients sustained type 2B gartland fracture. Also in our study, on comparing divergent and parallel lateral pinning techniques, divergent pins provided the better stability with least change of mean Baumann's angle of 2.82 degree at the end of 14 weeks whereas change in mean Baumann' s angle in parallel pins were 5.53 degree at the end of 14 weeks when compared to immediate postop.

Eventhough according to Skagg's grading system, this 5.53 degree was not a significant displacement comparing divergent pins this difference is statistically significant. Hence divergent pins confers better stability in our study. Gordon et al had concluded significant rotational instability on using only 2 lateral pins in gartland type 3 fractures on compared with usage of 3 lateral pins.[11] In our study also, using 3 lateral pins confered better stability than using only 2 lateral pins. Zionts et al had demonstrated the high torsional strength for cross pin configuration though it was not statistically significant on comparing with lateral parallel and lateral cross pin configurations.[12]

Several studies had been shown variable results regarding the outcome depending on the pin configuration. Otsuka et al have demonstrated that cross pinning configuration provides better stability than lateral pinning configuration.[13] Several studies have concluded that lateral pinning configuration confers equal stability as cross pin configuration.[14-16] In our study at the end of 14 weeks comparing immediate postop, change in mean Baumann's angle in cross pin fixation group was 4.13 degrees and in lateral pin fixation group was 4.15. This change was statistically insignificant. Lateral pinning group provided approvable stability when compared with cross pinning group in our study.

Zamzam et al have encountered 1.8% of ulnar nerve palsy after medial pinning using mini open technique in their study.[17] Lyons et al have shown 5.06 % of post operative ulnar nerve palsy after percutaneous medial pinning in their study.[18] In our study, among cross pin fixation group no patient experienced post operative ulnar nerve palsy. All the cross pinning surgeries among our study population were done by senior surgeons using mini open technique. Green et al have demonstrated the low incidence of ulnar nerve palsy in mini open technique for cross pinning.[19] Maity et al in their study comparing cross pinning and lateral pinning in the treatment of displaced supracondylar fractures have demonstrated statistically insignificant difference in outcome with respect to Flynn criteria in both the groups.[20]

In our study also, in terms of Flynn criteria, there were no statistically significant difference in outcome between cross pin fixation and lateral pin fixation groups. 4 patients in both the groups had fair outcome whereas other patients had excellent/good outcomes. There was 1.79 degree excessive loss of motion in cross pinning group compared to lateral pinning group. This excessive loss of motion in cross pinning group was not due to inadequate reduction because all the patients had adequate reduction which was checked by Roger's line intraoperatively. The reason for the reduced range of motion during earlier post pin removal period is attributed to be the anxiety because of the scar in the medial side and because of that patients could have restricted themselves doing range of motion of operated elbow that might have delayed attaining the complete range of motion. All the patients were addressed for range of motion during follow-up periods and were encouraged to do range of motion exercises and that improved the Loss of motion of elbow at the end of 14 weeks.

Certain limitations of this study included that the interobserver variation for measuring BA and LOM was not done. True postoperative anteroposterior and lateral radiographs were not able to obtain in some children since they were not cooperative that may affect the accuracy of variables. Carrying angle was not assessed in Flynn criteria, only loss of motion of elbow was assessed because of the fact that certain degree of fixed flexion deformity occurs in early postoperative period and the carrying angle cannot be measured in case of existing fixed flexion deformity.

CONCLUSION

The lateral pinning technique provides better stability as cross pinning technique in the management of displaced supracondylar fracture of humerus in children. In lateral pinning technique, using 3 pins with divergent

configuration provides better result in terms of loss of reduction. Lateral pinning technique is performed safely without the need for medial side skin incision and ulnar nerve manipulation that will prevent post-operative ulnar nerve neuropraxia. As the cross pinning needs skin incision, it results in a scar that is cosmetically inferior. Scar in the medial side in cross pinning increases the anxiety of the patient and the patients are conscious about the wound that prevents them from doing ROM exercises that needs additional counselling to attain the Range of motion whereas lateral pinning avoids such disadvantage. Cross pinning needs expertisation to handle the ulnar nerve and the lateral pinning avoids such disadvantage as lateral pinning is safely performed even by junior surgeons. From our study, we suggest lateral pinning technique with the use of 3 divergent pins for the treatment of displaced supracondylar fractures which gives stability as good as cross pin configuration and also avoids the risk of ulnar nerve injury.

ACKNOWLEDGEMENTS

We thank Sri Ramachandra institute of higher education and research for the constant support in academic works. We also thank Dr. Gopinath Menon, Dr. Mohankumar, Dr.Gokul Raj, Dr. Jambu, Dr. Srinivasan Rajappa, Dr. Giriraj Harshavardhan, Dr. Sridhar for their guidance and the support for doing this study.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

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Cite this article as: Paramasivam D, Ramachandran T, Ravindranath TP, Raja D, Sellakrishnan. Outcome analysis of cross-pinning versus lateral pinning and various lateral pinning configuration in the treatment of displaced paediatric supracondylar humerus fracture. Int J Res Orthop 2022;8:463-9.