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Original Research Article

A Comparative Study of Crossed Pinning Versus Lateral Pinning by Percutaneous K-wire in Paediatric Supracondylar Fractures of Humerus

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Abstract

Aim: The present study aims at comparing the functional outcome of percutaneous crossed pinning with lateral pinning.
Materials and Methods: An analysis of results with regards to ulnar nerve injury, carrying angle and range of movements was made in 17 children with lateral pinning and 28 children with crossed pinning. Functional outcome was graded according to Mitchell and Adams criteria.
Results: There was no statistically significant difference with regards to functional outcome, between two groups. Both methods produced satisfactory results in all cases. Ulnar nerve injury occurred in two cases (7%) after cross pinning. One case had significant palsy, which recovered by four months and the other had only ulnar nerve parasthesia.
Conclusion: Percutaneous pinning is an excellent method of treatment of type III supracondylar fractures in children. Crossed medial and lateral pinning may be considered the treatment of choice in majority of these fractures, with careful technique safeguarding against ulnar nerve injury. The lateral pinning is an equally good treatment of choice especially for grossly swollen elbows in which the medial epicondyle is barely palpable.
Keywords: Comparative study, lateral pinning, crossed pinning.

1. Introduction

Supracondylar fractures of humerus comprise about 17% of all childhood fractures. Extension type supracondylar fractures in children are classified into three types. Type I are the non displaced, type II are displaced with an intact posterior cortex and type III are completely displaced without cortical contact. Type IIIa have posteromedial displacement of distal fragment and type III b have posterolateral displacement. [1]

Cubitusvarus deformity is usually caused by failure to correct the rotational displacement of the distal fragment in the horizontal plane which leads to coronal tilting and anterior angulation of distal fragment. The deformity is cosmetic and does not interfere with the function. [2]

Treatment of supracondylar fractures have evolved over decades and three prerequisites are required for a good end result – an exact reduction, a safe fixation and careful follow-up.[3] Treatment of supracondylar fractures has included closed reduction and casting in hyper-flexion, traction, open reduction with pinning and closed reduction with pinning.

Most type II and type III supracondylar fractures may be managed urgently as opposed to emergently with closed reduction and percutaneous pinning within 24 hours. Indications for open reductions include irreducible fractures, vascular compromise, open fracture and post reduction nerve palsy. [4]

The goal of all forms of treatment is same i.e. to obtain and maintain an anatomic reduction of distal humerus to minimize complications such as nerve injury, compartment syndrome, Volkmann ischemic contracture, cubitusvarus deformity and limitation of elbow movements. The nonoperative management of type III fractures includes skin traction, skeletal traction and cast application. It has been associated with 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 has led to evolution of current techniques of percutaneous pinning for these difficult fractures. Standardization of surgical techniques for performing pin fixation with radiographic control has markedly reduced the incidence of poor outcomes.

The advantages of percutaneous pinning methods include easier management of extensively swollen elbows, better maintenance of reduction and decreased risk of associated complications.

2. Materials and Methods

The aim of our study was to compare the results of two types of pinning i.e. crossed pinning and lateral pinning in forty five children with Gartland type III supracondylar fractures of the humerus at the department of Orthopaedics, Shri Vasantrao Naik Govt. Medical College, Yavatmal between Aug 2010 to July 2012.

We included type III supracondylar fractures of humerus of either side, of either sex, children in the age group 2-12 years, who presented between 0-4 days of injury with no previous fractures in the same elbow. Details of the injury, treatment, x-rays, follow-up and results were recorded as per the prepared proforma.

Exclusion criteria were type I and Type II supracondylar fractures and those treated by open reduction. Immediately after the patients 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 percutaneous pinning under the guidance of C-arm image intensifier.

General anaesthesia was employed for all cases. The patients were positioned supine on the operating table with affected limb being placed on the side table or over the sterile draped C –arm image intensifier. Then a step-wise closed manipulation was performed.

Assessment of reduction was done clinically by assessing the carrying angle and radiographically by taking anteroposterior, lateral and Jone' s views.

Maintenance of reduction was achieved by passing two crossed K-wires from both the medial and lateral epicondyles or by passing two K-wires from the lateral condyle in a parallel or crossed fashion. When crossed pinning was employed the lateral pin was inserted first so that the medial pin could 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 randomization. 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 cut off and bent and a well padded posterior elbow slab was applied with elbow flexed to 90 degrees or less, as tolerated. Immediately in the post operative period, the neurovascular status of the limb was assessed. The K-wires were removed at four weeks interval as an outpatient procedure. The slab was continued till the end of four weeks. Active elbow exercises were started from fourth week as tolerated by the child, passive motion and forceful manipulation was avoided.

Follow-up was done regularly at 6 weeks, 3 months, six months and then once in six months. During this period pain, restriction of motion of elbow and satisfaction of patient was assessed. Carrying angle and the range of flexion and extension of both the injured and normal elbow was measured with a goniometer and recorded.

A neurological examination was performed to note recovery in case of a neural deficit being noted previously. Follow-up x-rays were done in immediate post operative period, at 3 weeks and at subsequent visits to note any displacement, malalignment and fracture union.

Finally, the functional outcome was assessed on the basis of Mitchell and Adams [5] criteria. The outcome was considered excellent, when movement of the elbow with a change in carrying angle of less than 5 degrees and limitation of elbow movement of less than 10 degrees. Results were graded as good, when the change in the carrying angle was between 5-15 degrees and limitation of movement between 10-20 degrees. When the change in carrying angle was more than 15 degrees and limitation of movements more than 20 degrees, the results were considered poor.

Statistical analysis was done by Chi-square test, t test and Fischer‘s exact test.

3. Observations and Results

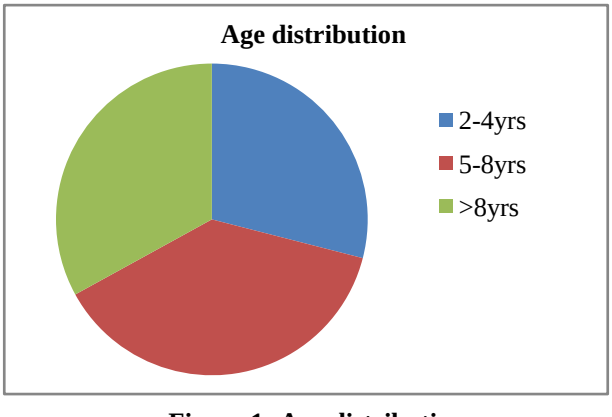

Figure 1: Age distribution

Mean age distribution of patients was 6.75years with a peak incidence in the age group of 5-8 years (38%), 2-4(29%), >8(33%)

Table I: Table showing frequency and percentage of gender distribution, side and type of fracture

	Frequency	percentage	Total
Male	32	71.1	45
Female	13	28.9	100%
Right side	14	31.1	45
Left side	31	68.9	100%
Posterolaterl fracture	10	22.2	45
Posteromedial fracture	35	77.8	100%

Table II: Table showing number and percentage of patients treated with crossed pinning and lateral pinning

	Frequency	Percentage
Lateral Pinning	17	37.6
Crossed Pinning	28	62.2
Median nerve injury	2	4.4
Radial nerve injury	2	4.4
nil	41	91.1
Total	45	100

The incidence of preoperative nerve injuries was 8.8% with median and radial nerve involved equally, there was no ulnar nerve injury.

Table III: Table showing Type of pinning versus complications which include ulnar nerve injury and pin tract infection

Type of Pinning	Lateral Pinning		Crossed Pinning	
	Frequency	%	Frequency	%
Number of pinning	17	37.8	28	62.2
Complication	1	5.9	4	14.2
Ulnar nerve injury	0	0	2	7.1
Pin tract infection	1	5.9%	2	7.1

Table IV: Comparison of loss of carrying angle and loss of range of motion in both types of percutaneous pinning

	Loss of Carrying angle		Loss of range of motion	
	Mean	Standard deviation	Mean	Standard deviation
Lateral pinning	3.12	2.3233	8.47	2.695
Crossed pinning	2.46	2.099	7.21	3.414
T test	0.955	P=0.345	1.291	P=0.204

The average change in carrying angle was 2.5 degrees for the lateral pinning group. The average loss of range of motion was 8.4degrees in the lateral pinning group and 7.2 degrees in crossed pinning group. The difference between the groups was not statistically significant.

Table V: Functional outcome versus type of pinning

			Type of pinning		Total
			Lateral	Crossed	
Functional Outcome	Excellent	Count	12	23	35
		Percent	70.6%	82.1%	77.8%
	Good	Count	5	5	10
		Percent	29.4%	17.9%	22.2%
Total		Count	17	28	45
		Percent	100%	100%	100%

There were 82% excellent and 18% good results in crossed pinning group and 71% excellent and 29% good results in lateral pinning group. The functional outcome between the two groups was not statistically significant.

Table VI: Showing Follow up of patients in months

Patients	Minimum	maximum	Mean	Std deviation
45	4 months	22mths	14.46mths	5.952

In this series type III extension type supracondylar fractures of humerus in children aged 2 to 12 years, who were treated by closed reduction with either crossed pinning or lateral pinning were studied. The cases were studied prospectively for functional outcome following the two types of pin placement.

To summarize the observations and findings in the study:

- The peak incidence in our series was between 5-8yrs with a mean age of 6.75years.
- Boys were more commonly affected than girls. (71% of cases).
- The left side was involved in 69% of cases.
- Fall on an outstretched hand was the most common mode of injury.
- Posterior-medial displacement of the distal fragment was observed in 78% of cases.
- 17 cases were treated with lateral pinning alone and 28 cases were treated with crossed medial-lateral pinning.
- The average follow-up period was 19.7 months. (Range 5-36 months).
- Transient ulnar nerve palsy following crossed pinning occurred in 2 cases (7%).
- Following crossed pinning, excellent results were found in 82%of cases and good results in 18% of cases.
- In cases treated with lateral pinning, there was no neurological complication post operatively.
- There were 71% excellent and 295 good results in cases treated with lateral pinning.
- The difference in functional outcome between the two groups was not statistically significant.

4. Discussion

In these study forty five children with type III supracondylar fractures of humerus that were treated with closed reduction and percutaneous crossed pinning (medial-lateral) or lateral pinning methods were evaluated prospectively.

The age group of patients considered was between 2 and 12 years. The peak incidence was in 5-8 years with an average of 6.7 years.

In our study incidence of supracondylar type III fractures was more in male children i.e. 71% and 29% in females. This male preponderance was noted in study by Wilkins [6] males 62.85% and of Solak [7] males 72.8%.

The left side was involved 2.2 times i.e. 69% of cases, more common than the right forearm, which is comparable to that of Aronson and Prager i.e. two times[8]. The common mechanism of injury in our study was a fall

on an outstretched hand i.e. in 96% of cases which is same as that in series by Mostafavi.[9]

In our study there was a 77% incidence of posteromedial displacements and 23% posterolateral displacements. The other series also showed a higher rate of posteromedial displacement. Wilkins 75% [6] Aronson and Prager 75% [8] and Mostafavi 82% [9].

The incidence of pre-operative nerve injury was 8.8% (6 cases) which is comparable to that in Wilkins series of 7.7% [6]. Radial and median nerves were equally involved with no ulnar nerve involvement. Neurological recovery was complete in all cases by 3 to 4 months. Ipasilateral injuries were present in 4 cases (8%). Fowles and Kasaab mentioned this to be 6% in their study.[10]

Radial pulsation was either weak or absent in 26 cases in our series but peripheral circulation was intact in all of them with normal dynamic functions of the hand. Oxygen saturation levels at the periphery were satisfactory in these cases. Cases with posterolateral displacement had more incidences of weak or absent radial pulse 80% as compared to cases with posteromedial displacement i.e. 51%. These cases were kept under constant observation with frequent neurovascular assessment. All cases regained normal radial pulsations with 24-36 hours following reduction of fracture and percutaneous pinnings. Fowle and Kasaab [10] had similar findings in their study.

The average hospital stay in our study was 4 days with a range of 1 to14 days. The average hospital stay in other study was 3.4 days by Aronson and Prager [8] and 4.2 days by Nacht *et al* [11]. The follow up period for cases ranged from 4months to 22 months with an average of 14.46 months. This was comparable to 17.2 months in study by Aronson and Prager [8]. The minimum duration of 5 months of follow-up in our series was adequate to asses fracture union, malalignment, range of motion and recovery from nerve injuries.

In our study a total of 45 cases were treated; 28 patients (62%) underwent crossed pinning with medial and lateral pins and 17 patients (38%) underwent lateral pinning –either parallel or crossed pinning. The choice of method of pin fixation was made according to operating surgeon's personal preference.

Pin tract infection with pin loosening occurred in3 patients in our study i.e. 6.6%. In the study by Mostafavi [9], the incidence of pin tract infection was 5%. Pin tract infection with pin loosening necessitated earlier removal of K wires at 2 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 3 patients with the above measures. The loss of range of motion and carrying angle were greater in these 3 patients compared to those without infection.

There were two cases i.e. 7% of iatrogenic nerve palsy following medial pinning. In one case there was only paraesthesia along the ulnar nerve distribution which subsided spontaneously in one week. In another case of nerve palsy there were both motor and sensory deficits but complete neurological recovery occurred by the end of four months. Iatrogenic nerve injury almost always involves the ulnar nerve following the placement of the medial pin for crossed pinning. First ten cases of cross pinning were associated with temprory ulnar nerve injury were reduced in our study by taking precautions such as inserting the lateral pin first and avoiding hyperflexion of elbow during medial pin placement.

The incidence of ulnar nerve injury with medial pinning in other series were8% in study by Skaggs *et al* [12] and 5%in study by Solak[7]. There were no iatrogenic nerve injuries following lateral pinning.

The correlation between the type of pinning and functional outcome was made on the basis of change in the carrying angle and range of motion as compared to normal side. In our study the average change in carrying angle for cases treated with lateral pinning was 3.1 degrees (range 0-8degrees) with 5 patients having change of carrying angle between 5-8 degrees. In the study by Aronson and Prager [8] this was 2.2 degrees (range 0-8 degrees). The average change in carrying angle in cases treated by crossed pinning was 2.5 degrees with range of 0 to 7 degrees. 5 patients had loss of carrying angle between 5-7 degrees in this group. The difference in carrying angle between two groups was not statistically significant (p=0.345). However there was no cubitusvarus deformity in either groups in our study and patients were satisfied with the cosmetic appearance of their elbows. This finding was in contrast to study by Davis *et al* [13] who reported a13% incidence of cubitusvarus.

The slightly higher change of carrying angle in lateral pinning cases might be related to a comparatively less stable construct with two lateral pins compared to two crossed pins. Biomechanical studies by Ziontis [14] have demonstrated that crossed pinning is more stable than lateral pinning in rotational testing as well as varus and valgus loading. However a study by Skaggs *et al* [12] demonstrated no clinical difference in stability between crossed and lateral pins.

In our study the average loss of range of movement was 7.2 degrees (range 0-16 degrees) for cases with crossed pinning, this compared favourably with series by Nacht *et al* [11] i.e. 7.8 degrees. For cases with lateral pinning the average loss of range of movement was 8.4 degrees (range 0-14 degrees) which compares favourably with the study by Aronson and Prager [8] which demonstrated a loss of range of movement of 10 degrees. The difference with regards to loss of range of movement between the two groups was not statistically significant

(p=0.204) with both groups showing excellent or good range of movements.

No significant improvement in range of motion was observed between the sixth month clinical follow up and the final follow up. It is therefore inferred that no significant change in range of motion could be obtained after the first six months following surgery.

Functional outcome following two types of pinning was evaluated according to Mitchell and Adams criteria [5]. The functional outcome was excellent in 82% and good in 18% of cases. There were no poor results. This compared favourably with series by Mostafavi[9] with 88% excellent results. The cases treated with lateral pinning showed 71% excellent and 29% good results with no poor results. In the series by Aronson and Prager [8] excellent results were found in 88% and good results in12%. The difference in functional outcome between two groups was not statistically significant (X2=0.817 P=0.366).

5. Conclusion

In our study we observed that closed reduction and percutaneous pinning is an excellent method of treatment of type III supracondylar fractures in children. Crossed medial and lateral pinning is the treatment of choice in these fractures, careful technique during crossed pinning would reduce the chances of ulnar nerve Injury.

We also observed that the lateral pinning is an equally good treatment of choice especially for the grossly swollen elbows in which the medial epicondyle is barely palpable with increased risk of ulnar nerve injury during the placement of the medial pin(in crossed pinning).

Both methods offered consistently satisfactory functional and cosmetic results. Cubitusvarus, the commonest complication of this fracture, was virtually eliminated in our study.

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