

Displaced supracondylar fracture of humerus in children treated with crossed pin versus lateral pin: A Hospital based Study from Western Nepal

CHAKRABORTY M K, ONTA P R, SATHIAN B

ABSTRACT

Background: The supracondylar fracture of the humerus is the second most common fracture in children and the most frequent one in the first decade of life. Close reduction with percutaneous pin fixation has become the treatment of choice. The success of the treatment depends on the strength of the fixation and the avoidance of complications. Crossed pin (medial and lateral pin) and two lateral parallel pin fixations after the reduction of the fracture are recommendable.

Objective: To compare the efficacy of the two recommended methods of internal fixation of the displaced supracondylar fractures, Gartland's Type II and Type III of the humerus in children.

Material and Methods: This was a hospital based retrospective study which was conducted in Nepal between January 2010 and June 2011.

Results: Out of the 92 patients, 56 (60.9%) were fixed with a medial lateral cross pin and 36 (39.1%) were fixed with lateral two parallel pins. The average age of the patients who were fixed with the medial lateral cross pin was $7.5 \pm$ SD 2.3 years and that of those who were fixed with the lateral two parallel pins was $7.6 \pm$ SD 3.0 years. 24 (26.1%) patients had type II and 68 (73.9%) had type III fractures.

Conclusion: In our study, crossed pinning was found to be superior to the two parallel lateral pinning; because crossed pinning had more stability.

Key Words: Supracondylar fracture, crossed pin, lateral pin

KEY MESSAGE

- In cases of displaced supracondylar fractures of the humerus in children who were treated with crossed pin versus lateral pin, crossed pinning was found to be biomechanically more stable.
- Pin fixation is always controversial; lateral pin fixation is not stable enough against torsional forces.
- To avoid iatrogenic ulnar nerve injury in case of medial pinning, the relative extension of the elbow is done after the lateral pinning fixation.
- Cross pinning has been recommended in Gartland's Type III fractures. In cases of severe swelling, a medial incision to see the entry point of the medial pin is required to prevent the iatrogenic ulnar nerve injury.

INTRODUCTION

The supracondylar fracture of the humerus occurs most commonly in children under seven years of age and it is more common in boys than in girls [1, 2]. Injuries are involved in the left or the non-dominant sites. The extension type of fracture is the most common one which is found in children [3].

The displaced supracondylar fracture of the humerus, after reduction, is fixed with pins and is immobilized in a plaster slab. The two principal configurations which have been reported in the literature for displaced supracondylar fractures are two lateral parallel pin fixation and cross (medial and lateral) pin fixation.

The functional and cosmetic outcome is closely related to a successful close reduction and percutaneous pin fixation. Iatrogenic ulnar nerve injury [4], instability, redisplacement and late malunion with varus deformity are the known complications. In displaced supracondylar fracture of the humerus in children who were treated with cross pin versus lateral pin, crossed pinning was found to be biomechanically more stable [5].

MATERIAL AND METHODS

This was a hospital based, retrospective study which was conducted in the Orthopaedic Department of Manipal College of Medical Sciences, Pokhara, Nepal, between January 2010 and June 2011. The variables which were collected were age, gender, crossed pin versus lateral pin, the mode of injury and the affected side. The displaced extension type supracondylar fractures in children were treated at our institute by closed reduction and percutaneous pinning.

The exclusion criteriae were open fractures, fractures that required open reduction, previous ipsilateral elbow fracture and the presence of any concomitant fractures in the ipsilateral limb. We reviewed the hospital records of the study cohort for details which included pre-operative clinical examinations, operative note, postoperative evaluation, duration of the immobilization and the time of the pin removal. When there were complications, there was a need for further surgeries and clinical assessment at the follow up visit.

A total of 92 children fulfilled the inclusion criteriae of the study,

including 72 boys and 20 girls. Their mean age was 7.5 years; 44 were right sided and 48 were left sided. There were 24 Gartland's type II fractures and 68 Gartland's type III fractures. All the children underwent closed reduction and percutaneous pinning. The pin size was selected according to the age of the child and the size of the arm, which was usually 1.5 mm for the younger children and 2.0 mm for the older children. The pin configuration was based on the testing post reduction and the fracture stability intraoperatively, with the image intensifier and considering the severity of the elbow swelling.

While placing the medial pins, we followed the flexion-extension cross pinning technique which was described by Eidelman et al [6]. The pin ends were bent outside the skin, and an above elbow POP slab was applied, with approximately 90 degree of elbow flexion and neutral forearm rotation. All the children were discharged to go home on the post-operative day three and were again reviewed 1 week after the surgery, by checking their orthogonal plain radiographs. If these were acceptable, the child was seen again after 3 weeks when the cast was removed and the check-up X rays were taken. Whenever an acceptable healing was confirmed, the pins were removed at six weeks in the OPD and motion was encouraged.

Physiotherapy was rarely indicated. The follow-up was continued until the full range of the motion was regained. The average follow-up period was 7.4 [5–3,6] months. The clinical and radiological assessments were analyzed at the final visit. The clinical assessment included the range of motion, the carrying angle, neurological and vascular examination and return to the full function. A radiological assessment was made by comparing the Baumann's angle in the initial post-operative and in the final follow-up radiographs. The analysis was done by using descriptive statistics and the testing of the hypothesis. The data was analyzed by using Excel 2003, the Statistical Package for the Social Sciences (SPSS) for Windows Version 16.0 (SPSSInc; Chicago, IL, USA) and the EPI Info 3.5.1 Windows Version. The Chi-square test was used to examine the association between the different variables. A p-value of < 0.05 (two-tailed) was used to establish the statistical significance.

RESULT

Out of the 92 patients, 56 (60.9%) were fixed with a medial lateral cross pin and 36 (39.1%) were fixed with lateral two parallel pins. The average age of the patients who were fixed with the medial lateral cross pin was $7.5 \pm SD 2.3$ years and that of those who were fixed with the lateral two parallel pins was

$7.6 \pm SD 3.0$ years. 24 (26.1%) fractures were of type II and 68 (73.9%) were of type III.

The average immobilisation time in the present study was 5.1 ± 1.04 (4–8) weeks.

[Table/Fig 1]: Shows cross pinning A-P and the lateral of the pre and post-op views with the type 3 fracture.

In 10% of the cases, we noticed irritability of ulnar nerve which resolved spontaneously and there was a mild degree of secondary varus deformity.

[Table/Fig 2]: Shows lateral pinning A-P and the lateral of the pre and post-op views. The chance of the varus deformity and the 20 degree rotational deformity had only little clinical and functional significance. The varus deformity was the only cosmetic problem. The deformity of the ulnar canal could cause irritation of the ulnar nerve in 10% of the cases. After 3 weeks, it was noticed that all the



[Table/Fig-1]: Cross-Pinning pre and post op



[Table/Fig-2]: Two parallel pinning Pre and Post op



[Table/Fig-3]: Pre and Post-operative X-ray picture of two parallel pinning

cases were stable enough for motion.

[Table/Fig 3]: AP and lateral pre and post op views of lateral pinning by divergent methods; biomechanically it is not as strong as cross pinning.

DISCUSSION

The success of the treatment of displaced supracondylar fractures of the humerus in children depends on good reduction, maintenance of the reduction until fracture healing with avoidance of complications and achieving better functional and cosmetic results.

The pin fixation technique is always controversial. It involves the use of two lateral pins which are placed in either a parallel or a divergent pattern. The latter is more biomechanically stable and therefore it is more popular, with a minimal risk of ulnar nerve injury [7].

Adult cadavers and synthetic paediatric bone models have suggested that lateral pins fixation is not stable enough against torsional forces [8], and that an additional lateral pin must be added whenever necessary, to control rotational instability [7]. Zoints et al showed that the torque which was required to produce 10% rotation was 40% less for two lateral pins than for a two cross pin [7].

In type II fractures, the rotational stability was better, because of the intact bone or the periosteum, posteriorly. The type III fractures developed rotational instability and the cubitus varus deformity due to tilting. The posterior displacement, coronal tilt and the horizontal rotation of the distal fragment were evaluated radiologically to overcome the cubitus varus deformity.

In our study on a total number of 92 cases, a cross pin was fixed in 56 cases and a lateral pin was fixed in 36 cases. The mode of injury was mostly falling while playing. There were 12 cases (33.33%) of pin tract infection in lateral pinning and 40 cases (71.42%) in cross pinning which were tackled with antibiotics. The incidence of the pin tract infection was superficial, may be because of poor hygiene and scratching due to post op irritability, which was treated adequately with oral antibiotics and it was resolved completely. So, it was not a problem.

Radial nerve injury was found in 4 (11.11%) cases in lateral pinning and 4 (7.14%) cases of ulnar nerve palsy in cross pinning. Mild cubitus varus deformity (Baumann's angle 5 to 8 degree) was found in 4 cases (7.14%) in cross pinning and in 10 cases (27.78%) in lateral pinning. Four iatrogenic ulnar nerve injuries were explored and healed up without any residual palsy. Four radial nerve injuries in the lateral pinning group also healed up. In cases of severely swollen elbow, we preferred to make a small incision over the medial epicondyle to explore the ulnar nerve, to avoid injury to it.

The incidence of iatrogenic ulnar nerve injury in medial pinning was 1.4 to 15.6% [9]. The incidence of ulnar nerve injury in our study was 7.14%, which is comparatively low and insignificant because it healed up completely without any residual complications. In our study, only 7.14% cases of ulnar nerve injury were found. There were only four radial nerve injuries among the lateral injuries. Only four iatrogenic ulnar nerve injuries were explored, which healed without any residual palsy. Only in cases of severe swelling, we made a small medial incision because it was very difficult to find the location. Manipulation and hardware insertion may be partially responsible for such injuries.

Biomedical studies have shown that cross pinning was 25% more rigid and 37% more stronger than the two lateral parallel pins [5].

Mode of injury	Supracondylar fracture of humerus treated		Total (%)
	Crossed Pin (%)	Lateral Pin (%)	
fall after push from friends	4(7.14)	0(0)	4(4.35)
fall from height	12(21.43)	4(11.11)	16(17.39)
fall from stairs	4(7.14)	0(0)	4(4.35)
fall from swing	8(14.29)	0(0)	8(8.70)
fall from tree	4(7.14)	8(22.22)	12(13.04)
fall in ground	4(7.14)	0(0)	4(4.35)
fall while playing	20(35.71)	24(66.67)	44(47.83)
Total	56	36	92
Complications			
Mild pin tract infection	40(71.43)	12(33.33)	52(56.52)
Radial nerve palsy	2(3.57)	4(11.11)	6(6.52)
Ulnar nerve palsy	4(7.14)	0(0.00)	4(4.35)
Intra operative instability	6(10.71)	10(27.78)	16(17.39)
Cubitus varus deformity	4(7.14)	10(27.78)	14(15.22)
Total	56	36	92

[Table/Fig-4]: Mode of injury and complication wise comparison of supracondylar fracture of humerus treated

In lateral two parallel pin fixation, the occurrence of intraoperative instability and redisplacement may not allow the full extension of the elbow. Mild cubitus varus deformities are more and not adequate enough for intraoperative stability for torsional forces, more over 4 (11.11%) radial nerve injury. The lateral pins are more close to the epiphysis of the distal humerus and they may disturb the growth plate and may cause mild cubitus varus deformity.

To avoid iatrogenic ulnar nerve damage while inserting the medial pin, a relative extension of the elbow at a maximum of 60 degrees of flexion was done after inserting the lateral pin. The technique of extending the elbow before the placement of the medial pin may have been responsible for avoiding an incidental injury to the ulnar nerve in our cases.

The choice of the pin configuration was based on the intraoperative stability and the severity of the elbow swelling. In the current concept of Bloom et al, they reported that three lateral pins were biomechanically equivalent to two cross pins; but that the cross pins were stronger than the two lateral pins.

CONCLUSION

Cross pinning has been recommended in the Gartland's type III fractures. In case of severe swelling, a medial incision to see the entry point of the medial pin is required to prevent the iatrogenic ulnar nerve injury.

Two lateral pin fixations may be suitable only for the type II fractures, where the rotational stability is better because of the intact bone and the periosteum, posteriorly.

In the type III fractures, it may be redisplaced due to lack of enough stability and so we recommended cross pinning.

The final outcome of the low iatrogenic ulnar nerve injury in the type III fractures is possible if adequate care is taken by proper medial pin fixation in cross pinning. The initial ulnar and radial nerve injuries and the pin tract infection were usually resolved without any

residual complications.

In our experience, in cross pinning, the lateral pin should be fixed first, followed by the medial pin, with the elbow in extension. Most of the ulnar nerve injuries may be avoided by this technique, with the advantage of a strong and stable fixation.

REFERENCES

- [1] Morris S, McKenna J, Cassidy N, McCormack D. Elbow injuries in the paediatric population: fractures of the distal humerus. *Irish J Orthop Surg Trauma* 2001;4:189-93.
- [2] Cheng JC, Lam TP, Maffulli N. Epidemiological features of the supracondylar fractures of the humerus in Chinese children. *J Paediatr Orthop B* 2001;10:63-7.
- [3] Gordon JE, Patton CM, Luhmann SJ, et al. Fracture stability after the pinning of the displaced supracondylar distal humerus fractures in children. *J Paediatr Orthop* 2001;21:313-8.
- [4] Devkota P, Khan JA, Acharya BM, Pradhan NM, Mainali LP, Singh M, Shrestha SK, Rajbhandari AP, et al. Outcome of the supracondylar fractures of the humerus in children who were treated by closed reduction and percutaneous pinning. *JNMA J Nepal Med Assoc.* 2008 ;47(170):66-70.
- [5] Brauer CA, Lee BM, Bae DS. A systematic review of medial and lateral entry pinning versus lateral entry pinning for the supracondylar fractures of the humerus. *J Paediatr Orthop* 2007;27:181-6.
- [6] Eldelman M, Hos N, Katzman A, Bialik. V. Prevention of ulnar nerve injury during the fixation of supracondylar fractures in children by the "flexion- extension cross pinning" technique. *J Paediatrorthop B* 2007;16:221-4.
- [7] Zionts LE, McKellop HA, Hathaway R. The torsional strength of pin configurations which was used to fix supracondylar fractures of the humerus in children. *J Bone Joint Surg (Am)* 1994; 76:253-6.
- [8] Yen YM, Kocher MS. Lateral entry compared with medial and lateral entry pin fixation for completely displaced supracondylar humeral fractures in children. A surgical technique. *J Bone Joint Surg Am.* 2008 Mar;90 (Suppl 2 Pt 1):20-30.
- [9] Kalenderer O, Reisoglu A, Surer L, Agus H. How should one treat an iatrogenic ulnar injury after the closed reduction and percutaneous pinning of paediatric supracondylar humeral fractures? *Injury* 2008; 39:463-6.

AUTHOR(S):

1. Dr. Chakraborty M K
2. Dr. Onta P R
3. Dr. Brijesh Sathian

PARTICULARS OF CONTRIBUTORS:

1. Prof & HOD, Orthopaedics Department, Manipal College of Medical Sciences, Pokhara, Nepal.
2. Senior Resident, Orthopaedics Department, Manipal College of Medical Sciences, Pokhara, Nepal.
3. Assistant Professor, Department of Community Medicine, Manipal College of Medical Sciences, Pokhara, Nepal

NAME, ADDRESS, TELEPHONE, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Manoj Kumar Chakraborty,
MS (Orth), DPMR, FICS
Prof & HOD, Orthopedics Department,
Manipal College of Medical Sciences, Pokhara, Nepal.
Ph.: 00977-9726155900
Email : drmkc2010@yahoo.com

DECLARATION ON COMPETING INTERESTS:

No competing Interests.

Date of Submission: Jul 05, 2011
Date of per review: Aug 18, 2011
Date of acceptance: Sep 11, 2011
Date of Publishing: Nov 11, 2011