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Medial and Lateral Percutaneous Fixation versus Lateral Fixation for Treatment of Gartland Type II, III Supracondylar Fracture of Humerus in Children

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Abstract

Background Operative treatment of supracondylar fractures with reduction and percutaneous pinning is so effective and safe. The great majority of displaced fractures should be treated operatively. There is little controversy that all closed Gartland type II and III fractures should have an attempt at closed reduction and pinning.

Objective To compare the efficacy of medial and lateral entry pinning with lateral entry pinning for percutaneous fixation of displaced (Gartland type II and III) extension type supracondylar fractures of the humerus in children.

Methods A prospective study conducted at a single centre from December 2008 to November 2011. Eighty patients who satisfied the inclusion and exclusion criteria were enrolled in the study, with 40 patients in each group. All the pinning was done according to a uniform standardized technique. The patients were re-evaluated as outpatients at three weeks, six weeks and three months after the surgery.

Results No significant differences were found between the two groups with regard to base-line characteristics, withdrawals, complication rate and various outcome measures such as carrying angle, passive range of elbow motion, Flynn grading, Baumanns angle, change in the Baumann angle and loss of reduction grading.

Conclusions If a uniform standardized operative technique is followed in each method, then the result of both methods will be same in terms of safety and efficacy.

Keywords Supracondylar fractures, Humerus, Children, Percutaneous fixation

List of abbreviations: K-wires = kurschner wires, AP = anteroposterior, ORIF = open reduction and internal fixation, gm = gram, IV = intravenously, Deg = degree.

Introduction

Supracondylar fractures of the humerus are the most common type of elbow fracture in children and adolescents. They account for 50% to 70% of all elbow fractures and are seen most frequently in children between the ages of 3 and10 years [(1)].

Supracondylar fractures are produced by forcibly hyperextending the elbow. The level of the fracture is determined by the olecranon forming a fulcrum in the supracondylar region [(2)]. Prevention of cubitus varus or valgus or loss of flexion and extension by obtaining as anatomical a reduction as possible is necessary. The Gartland classification is useful for determining appropriate treatment for supracondylar fractures: type I, undisplaced; type II, displaced with intact posterior cortex; and type III, displaced with no cortical

contact[3].

Posterior displacement and tilt is the commonest (95% of all cases), suggesting a hyperextension injury, usually due to a fall on the outstretched hand. The jagged end of the proximal fragment pokes into the soft tissues anteriorly, sometimes injuring the brachial artery or median nerve. Anterior displacement is rare, but may result from over-reduction of the usual posterior displacements [4].

Treatment

The initial evaluation of these fractures should include a careful evaluation of the medial distal humerus, with consideration of the need for contralateral comparison radiographs. Subtle comminution of the medial distal humerus in an otherwise minimally displaced fracture can lead to cubitus varus [5].

Attempts have been made to correlate various radiographic measurements with adequate fracture reduction Baumann angle is the most frequently cited method of assessing fracture reduction and has been reported to correlate well with the final carrying angle, not to change significantly from the time of initial reduction to final follow-up, and not to be obscured or invalidated by elbow flexion or pronation [3].

Reported normal values range from 9 to 26 degrees. A common rule of thumb is that a Baumann angle of at least 10 degrees is acceptable [3].

Studies of the pin configuration for supracondylar fractures have compared the use of medial- and lateral entry crossed pins with the use of lateral-entry pins alone. Biomechanical studies found that crossed pins are stronger in torsion than a lateral-entry construct. Proponents of lateral-only pins cite a lower incidence of iatrogenic nerve injury with these pins [5].

The objectives of this study was to compare the efficacy of medial and lateral entry pinning with lateral entry pinning for percutaneous fixation of displaced (Gartland type II and III) extension type supracondylar fractures of the humerus in children.

Methods

This study is a prospective, randomized controlled clinical trial, conducted in Department of Orthopaedics and Traumatology in Al-Imamain Al-Kadhimain Medical City from December 2008 to November 2011. Written informed consent was obtained from the study participants.

The study included 80 patients with age range from two to twelve years who had supracondylar fractures. The patients divided into two groups 40 patients in each.

Inclusion criteria: (1) age between two and twelve years (2) unilateral fracture (3) extension type (4) Gartland type II and type III (5) patients presenting within seventy two hours after the injury (6) no other associated injury in the same limb (7) no previous fracture in the same limb.

Exclusion criteria: (1) open fractures (2) fractures that required open reduction and (3) patients with neurovascular abnormalities that were found at the time of presentation.

At three months follow-up visit, following information were recorded as outcome measures: (1) Carrying angle (degree) (2) passive range of elbow motion (degree) (3) Flynn's criteria for grading, based on the loss of carrying angle and loss of total range of elbow motion. (4) Baumanns angle (degree) (5) Change in Baumann angle (degree) between the Intraoperative radiographs after the surgery and radiographs at three months follow-up visit (6) loss of reduction grading, based on the change in the Baumann angle.

Surgery was done under general anaesthesia by more than one surgeon. All the patients were positioned supine on a fracture table and closed reduction were performed under the fluoroscopic control. The method of reduction was initial traction in an extended position of the elbow joint, followed by flexion and dorsal pressure with the thumb on the distal fragment in extension-type fractures and simultaneously pronating the forearm. Fracture reduction with flexed elbow joint was evaluated in a position of 90° external rotation, in the anteroposterior

view, and in 90° internal rotation .Fractures are fixed either by two lateral wires (Figure 1 & 2), or by medial and lateral wires as in figure 3.

The patients were re-evaluated as outpatients at three weeks, six weeks and three months after the surgery. The same surgeon throughout the trial did follow-up assessment of each patient.

At three months follow-up visit, the following information were recorded as outcome measures: (1) carrying angle (degree) (2) passive range of elbow motion (degree) (3) Flynn's [6] criteria for grading, based on the loss of carrying angle and loss of total range of elbow motion (Table 1) (4) Baumann angle (degree), calculated on the anteroposterior view of elbow (5) The Change in Baumann angle (degree) between the Intraoperative radiographs after the surgery and radiographs at three months follow-up visit (6) loss of reduction grading, based on the change in the Baumann angle.

The major loss of reduction (defined as a change in the Baumann angle of > 12° between the Intraoperative radiographs and radiographs at three months was selected.

Fig. 1. Lateral x-ray of 6 years old patient with supracondylar fracture humerus treated with closed two lateral K wires

Table 1. Flynn's criteria for grading

Result	Rating	Carrying angle loss (Degrees)	Total range of elbow motion loss (Degrees)
Satisfactory	Excellent Good Fair	0-5 5-10 10-15	0-5 5-10 10-15
Unsatisfactory	Poor	Over 15	Over 15

Fig. 2. AP x-ray of the same patient

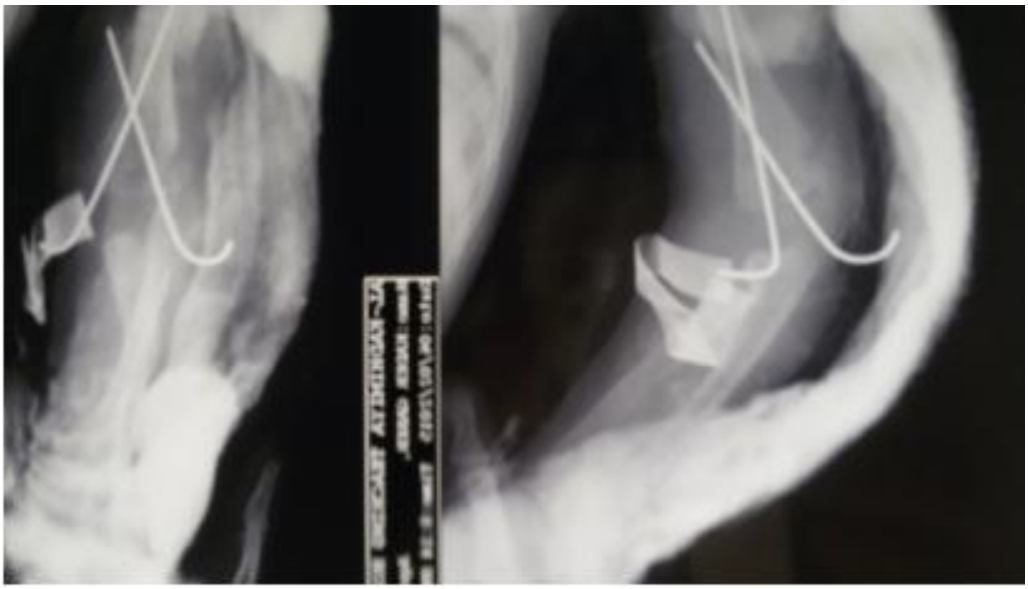

Fig. 3. AP & Lateral x-rays of 3 years old patient treated with closed medial & lateral k wires

Statistical analysis

Chi-square test was used for comparison between the groups. *P* value of < 0.05 was considered statistically significant.

Results

There were no significant differences between the two groups regarding base-line characteristics such as age, male sex, side, types of displacement, and types of fracture, interval from injury to admission and interval from admission to surgery (Table 2).

Complications

There were no significant differences between the two groups regarding neurovascular complications at the time of admission, iatrogenic ulnar nerve injury, and pin track infection (Table 3).

At three months follow-up visit, patients were evaluated by recording the various outcome measures. There were no significant differences between the two groups with regard to the various outcome measures such as carrying angle, passive range of elbow motion, Flynn grading, Baumann angle, and change in the Baumann angle and loss of reduction grading (Table 4).

Table 2. Baseline characteristics of 80 patients with displaced (Gartland type II and III) extension type supracondylar fractures of humerus

Baseline Characteristics		Crossed medial-lateral pin entry group (N = 80)	Two-lateral pin entry group (N = 80)	*P* value
Age (years)		6.24 ± 1.77	6.12 ± 1.82	0.67
Male sex [11] (% of patients)		38 (95)	37 (92)	0.74[v]
Side [11] (% of patients)	Left	26 (65)	28 (70)	0.53 [v]
	Right	14 (35)	12 (30)	
Types of Displacement [11] (% of patients)	Posterolateral	28 (70)	26 (65)	0.71 [0]
	Posteromedial	9 (22)	9 (22)	
	Posterior	3 (7)	5 (13)	
Types of fracture according to Gartland [41 (% of patients)] [11]	Type II	28 (70)	17 (42)	0.75 [v]
	Type III	12 (30)	20 (50)	
Interval from admission to surgery (hours)		25.4 ± 1026	23 ± 8.78	0.11
Interval from injury to admission (hours)		27.8 ± 16.12	29.47 ± 11.74	0.45

t: the data are given as the mean ± standard deviation. 11: the data are given as the number (%) of patients. Independent-sample student t test. V = Fisher's exact, 0: Chi-square test.

Table 3. Complications of the 80 patients with (Gartland type II and III) extension type supracondylar fractures of humerus randomly assigned to receive percutaneous fixation with either crossed medial-lateral pin or, two-lateral pins

Complications	Crossed medial-lateral pin entry group t (n = 40)	Two-lateral pin entry group* (n = 40)	*P* value
Neurovascular complications at the time of admission [w]			0.75 [11]
Radial nerve injury	6 (15)	5 (12.5)	
Median nerve injury	9 (22.5)	12 (30)	
Pulse less pink hand	7 (17.5)	6 (15)	
latrogenic ulnar nerve injury [w]	0	0	1.0 [p]
Pin track infection at three weeks follow-up visit	2 (5)	3 (7.5)	1.0 [p]

W: The datas are given as the number (%) of patients. 11: Chi-square test. P: Fisher's exact test

Table 4. Comparative outcome measures at three months after the surgery in both groups

Outcome measure		Crossed medial-lateral pin entry group t (n = 34)	Two-lateral pin entry group * (n =36)	*P* value
Carrying angle (degree)n		5.52 ± 3.77	5.56 ± 4.62	0.95
Loss of Carrying angle (degree) [n]		3.58 ± 3.08	3.86 ± 3.33	0.62
Passive range of elbow motion (degree) [n]	Flexion	128.3 ± 12.67	127.96 ± 438	0.75
	Extension	-2.6 ± -0.13	-2.56 ± -0.16	0.12
	Total range of motion	130.58 ± 3.9	129.39 ± 4.48	0.111
Loss of total passive range of elbow motion (degree) [n]		3.4 ± 2.9	3.8 ± 3.21	0.45
Flynn grading (% of patients) [11]	Excellent	27 (80)	26 (73)	0.84 [Ay]
	Good	3 (9)	4 (12)	
	Fair	4 (11)	6 (15)	
	Poor	0	0	
Loss of reduction grading (% of patients) [11]	Major	0	0	0.94 [v]
	Mild	5 (15)	4 (12)	
	None	29 (85)	32 (88)	
Baumann angle (degree) [n]		772 ± 435	76.2 ± 3.51	0.15
Change in the Baumann angle (degree) [IT]		3.57 ± 2.43	3.71 ± 2.1	0.72

n: the datas are given as the mean ± standard deviation, 11: The datas are given as the number (%) of patients, IT: independent-sample student t test, Ay; Chi-square test. V: Fisher's exact test.

Discussion

The standard treatment for displaced (Gartland type II and III) extension type supracondylar fractures of the humerus in children is closed reduction and percutaneous pin fixation. But, controversy persists among authors regarding optimal method of percutaneous pin fixation. Swenson [(7)], Casiano [(8)] and Flynn et al [(6)] used two crossed medial-lateral pins. Arino et al [(9)] used two lateral pins.

Though crossed medial-lateral pin configuration provides good biomechanical stability, but

simultaneously it carries the increased risk of iatrogenic ulnar nerve injury due to placement of the medial pin. Conversely, though the two-lateral pin configuration carries less risk of iatrogenic ulnar nerve injury, but it provides less biomechanical stability

In this study comparison of the efficacy of medial and lateral entry pinning with lateral entry pinning for percutaneous fixation of displaced (Gartland type II and III) extension type supracondylar fractures of the humerus in children.

In the present study, there was no significant difference between the two groups with regard to iatrogenic ulnar nerve injury and loss of reduction grading.

Though several studies [10-16] have been done so far to compare the efficacy of medial and lateral entry pinning with lateral entry pinning for percutaneous fixation of displaced (Gartland type II and type III) extension type supracondylar fractures of the humerus in children but, it is very difficult to compare between them because: (i) pinning technique, pin size, position of elbow during pinning differs in various studies, (ii) only one study [10] consists of more than 40 patients in each group but, that was a retrospective study, (iii) Most of the studies were retrospective and uncontrolled [10-15]. Only two studies [13,15] were randomized controlled but, these studies consist of less than 40 patients in each group. All of these studies found no significant difference between the two methods in terms of loss of reduction and six studies found no significant difference between the two methods in terms of iatrogenic nerve injury. Only one shows significant difference in favour of lateral entry pinning method in terms of iatrogenic nerve injury. So, convincing evidence of the optimal method of percutaneous pin fixation is lacking in various literature overviews.

Brauer et al [17] performed a systematic review using pooled data of 2054 children from 35 previous studies: 2 randomized trials, 6 retrospective studies and 25 case series. They found no significant difference between the two groups in terms of loss of reduction and iatrogenic nerve injury.

Therefore, the results of present study are consistent with the results of most of the previous studies consists of the same clinically relevant question.

The major strength of the present study is its prospective randomized design. All of the patients in each group were operated on according to a uniform standardized well-accepted technique. In addition, thorough follow-up assessment of each patient was done with the use of various clinical and radiological outcome measures at standardized intervals. Follow-up assessment of each patient was done by the same surgeon throughout the trial.

The major limitation of present study is that, both the surgeon and the patients were not blinded of the treatment received throughout the trial. Another weakness of this study is the number of patients who did not complete the three-month follow-up visit. However, as the rate of the patients lost to follow-up in this study is comparable with that in other studies, we do not believe that it hampers present results.

In conclusion, we found that if a uniform standardized operative technique is followed in each method, then the result of both the percutaneous fixation methods will be same in terms of safety and efficacy.

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Conflict of interest

The authors declare no conflict of interest.

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References

1. Herring JA, Tachdjians paediatric orthopaedics. 5th ed. Vol. 2. Philadelphia: Elsevier Saunders; 2014 p. 1265.
2. Wenger DR, Rangs M, Prings ME. Rangs children fractures. 3rd ed. Philadelphia: Lippincott Williams & Wilkins; 2005. p. 102.
3. Canale ST, Beaty JH. Campbells operative orthopaedic. 12th ed. Philadelphia: Elsevier Mosby; 2013. p. 1404.
4. Solomon L, Wawick D, Nayagam S. Apley's & Solomon concise system of orthopaedic and trauma. 4th ed. Boca Raton: CRC Press Taylor & Francis Group; 2014. p. 185
5. Flynn JM. (ed). American Academy of Orthopaedic Surgeon (AAOS) Orthopaedic knowledge update. 10 2014. p. 670.
6. Flynn JC, Matthews JG, Benoit RL. Blind pinning of displaced supracondylar fractures of the humerus in children. Sixteen years' experience with long-term follow-up. J Bone Joint Surg Am. 1974; 56: 263-72.
7. Swenson AL. The treatment of supracondylar fractures of the humerus By Kirschner-wire transfixion. J Bone Joint Surg Am. 1948; 30: 993-7.
8. Casiano E. Reduction and fixation by pinning "banderillero" style-fractures of the humerus at the elbow in children. Mil Med. 1960; 125: 262-4.
9. Arino V, Llurch EE, Ramriez AM, et al. Percutaneous fixation of supracondylar fractures of the humerus in children. J Bone Joint Surg Am. 1977; 59: 914-6.
10. Skaggs DL, Hale JM, Bassett J, et al. Operative treatment of supracondylar fractures of the humerus in children. The consequences of pin placement. J Bone Joint Surg Am. 2001; 83: 735-40.
11. Gordon JE, Patton CM, Luhmann SJ, et al. Fracture stability after pinning of displaced supracondylar distal humerus fractures in children. J Pediatr Orthop. 2001; 21: 313-8.
12. Davis RT, Gorczyca JT, Pugh K. Supracondylar humerus fractures in children. Comparison of operative treatment methods. Clin Orthop Relat Res. 2000; 376: 49-55.
13. Foead A, Penafort R, Saw A, et al. A comparison of two methods of percutaneous pin fixation in displaced supracondylar fractures of the humerus in children. J Orthop Surg (Hong Kong). 2004; 12:76-82.
14. Topping RE, Blanco JS, Davis TJ. Clinical evaluation of crossed-pin versus lateral-pin fixation in displaced supracondylar humerus fractures. J Pediatr Orthop. 1995; 15: 435-9.
15. Shamsuddin SA, Penafort R, Sharaf I. Crossed-pin versus lateral-pin fixation in pediatric supracondylar fractures. Med J Malaysia. 2001; 56(Suppl D): 38-44.
16. Kocher MS, Kasser JR, Waters PM, et al. Lateral entry compared with medial and lateral entry pin fixation for completely displaced supracondylar humeral fractures in children. A randomized clinical trial. J Bone Joint Surg Am. 2007; 89: 706-12.
17. Brauer CA, Lee BM, Bae DS, et al. A systematic review of medial and lateral entry pinning versus lateral entry pinning for supracondylar fractures of the humerus. J Pediatr Orthop. 2007; 7: 181-6.

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