ORIGINAL ARTICLE

Radiological Evaluation of The Stability of Crossed-Pins Versus Lateral-Pins Fixation in Displaced Supracondylar Fractures of Humerus

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ABSTRACT

Objective — *To compare the radiological evaluation of stability of closed reduction of supracondylar fractures of humerus treated by percutaneous two-crossed-pin fixation and 2–lateral pin fixation.*

Study design — *Randomized controlled trial.*

Place & Duration of study — *Orthopedic Unit Hayatabad Medical Complex Peshawar, from January 2008 to July 2009.*

Methodology — *Fifty patients with displaced supracondylar fracture of humerus presented between ages 1-12 year were randomly allocated in two groups of 25 patients each and were subjected to crossed-pin fixation and 2-lateral pin-fixation. Primary outcome measure was determined with the help of Baumann angle. Secondary outcome measure was determined with the help of Metaphyseal-Diaphyseal (MD) angle.*

Results — *Mean age of patients was 7.02 ± 2.25 year. Mean loss of Baumann angle and Metaphyseal-Diaphyseal angles were $5.36^0 \pm 2.22^0$ and $2.42^0 \pm 1.25^0$ respectively. The mean Baumann angle loss in the two cross pins fixation group and the 2-lateral pins fixation group were $5.56^o \pm 1.80^o$ and $5.16^o \pm 2.64^o$ respectively. The mean MD angle loss in the two crossed pins fixation group and the 2-lateral pins fixation group was $2.44^0 \pm 1.22^0$ and $2.40^0 \pm 1.23^0$ respectively. When loss of Baumann and Metaphyseal-Diaphyseal angles were compared between two methods of fixation using Student t test, no significant difference in the stability of two methods of pin fixation was observed.*

Conclusion — *Radiological analysis showed that both the techniques were effective in terms of stability.*

Key words — *Supracondylar fractures, Percutaneous pinning, Baumann angle.*

INTRODUCTION:

Supracondylar fractures are common elbow injuries in children accounting for 16% of all pediatric fractures and two-thirds of all hospitalizations for pediatric elbow injuries.[1] According to the Gartland system, supracondylar humeral fractures are classified as extension type I, II and III.[2] Severely displaced supracondylar humerus fracture are challenging injuries to treat and entail technically difficult procedures for orthopedic surgeons. The controversy remained in the literature with regards to the definitive management of these types of fractures. The literature supports closed reduction and percutaneous pinning as the treatment of choice for this fracture.[3] Percutaneous pinning is safe, cost effective, time saving and provides greater skeletal stability with excellent result. [4] The best pin configuration is debatable.

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Clinical assessment of carrying angle after fracture reduction is difficult and inaccurate because of swelling, bulky dressing and plaster. Most people rely on radiographic methods. Three methods are commonly used; 1) Metaphyseal-Diaphyseal angle (MDA); 2) humeral – ulnar angle; 3) Baumann's angle. Baumann angle remains a good indicator in an assessment of post reduction alignment and commonly used to evaluate fractures as it maintains an estimation of the carrying angle.[5,6] This study has been conducted to compare the radiological evaluation of the stability of 2- lateral pins fixations with two-crossed-pin fixation in the treatment of supracondylar fractures of humerus.

METHODOLOGY:

This randomized controlled trial was conducted from January 2008 to January 2009 with follow up of one year in Orthopedic and trauma department of Postgraduate Medical Institute, Hayatabad Medical Complex Peshawar. The inclusion criteria were children of 1-12 year age and extension type displaced supracondylar fracture of humerus. The exclusion criteria were open fracture and fractures with neurovascular compromise.

In all patients back slab was applied and neurovascular status analyzed. Informed consent for the study and surgery was taken. The patients were randomly allocated in two groups by lottery method. Patients in group A were subjected to two crossed-pin fixation, while patients in group B received 2- lateral-pin fixation.

Under general anesthesia closed manipulative reduction was performed and the reduction confirmed with the image intensifier by Baumann angle in anteroposterior plane. Normal Baumann angle ranges from 64-81^0 (mean 74^0). When reduction was acceptable, fractures were subsequently fixed with Kirschner-wire according to the selected configuration.

Stability of the two methods was assessed for loss of reduction of fracture after pin fixation. Primary outcome measure was determined with the help of Baumann angle and secondary outcome was determined with Metaphyseal-Diaphyseal angle. Patients were discharged on the first or second postoperative day. All the patients were followed in out-patient department at intervals of 2 weeks, 4 weeks, 12 weeks and one year. Back slab removed after 2 weeks and pins at 4th week.

Loss of Baumann angle and Metaphyseal-Diaphyseal angle were assessed by comparing the treated side with uninjured side, and then these compared between the two groups treated with the two methods of fixations. Flynn's criteria were used for reduction assessment.

All data were compiled and calculated with SPSS version 10. The descriptive measure, like mean and standard deviation were calculated for age and frequency / percentage were calculated for others qualitative variables. For loss of Baumann angle, Metaphyseal-Diaphyseal angle and loss of carrying angle, we looked into the value of differences comparing the treated side with the uninjured side. We then compared these values between the 2 groups treated with different method of fixation and analyzed them statistically with Student *t* test. The p value of less than 0.05 was taken as level of significance.

RESULTS:

Fifty patients were treated with two methods of percutaneous pinning with 25 patients in each group. Patients were followed for one year. The mean age was 7.02 ± 2.25 year. The age ranged from 1 to12 year. There were 33 (66%) males and 17 (34%) females**.** Left side 38 (76%) was the most dominant side of fracture as compared to the right side (n=12 - 24%).

The Baumann angle ranged from 66^o to 84^o with average of 78^o on the injured side while on uninjured side it was 64^o to 80^o with average of 72^o. Loss of Baumann angle in injured side ranged from 2^o to 8^o. When both sides were compared the mean Baumann angle loss was 5.36^0 ± 2.22^o. The mean Baumann angle loss in the two croseds pins fixation group and the 2-lateral pins fixation group were 5.56 ^{o} ± 1.80^o and 5.16 ^{o} ± 2.64 ^{o} respectively. When loss of Baumann angle were compared between two methods of fixation using Student *t* test, no significant difference in the stability of two methods of pins fixation found (table I).

The Metaphyseal-Diaphyseal angle ranged from 83^o to 95^o with average of 88^o on the injured side while on uninjured side it was 87^o to 92^o with average of 89^o. Loss of MDA on injured side ranged from 0 to 7^o. When both sides were compared, the mean MDA loss was 2.42± 1.25^o . The mean MD angle loss in the two crossed pins fixation group and the 2-lateral pins fixation group was 2.44 ± 1.22^o and 2.40 ± 1.23^o respectively. When compared between two methods of fixation, using Student *t* test, no significant difference in the stability of two methods of pins fixation found (table I).

At the final follow-up, using Flynn's criteria for cosmetic outcome, patients with two crossed-pin

Table I: Comparison of loss of Baumann angle and Metaphyseal-Diaphyseal Angle In Two Methods of Pin Fixation.

Parameter	Two Crossed Pins Fixation (mean ± SD)	2 – lateral pins fixation (mean ± SD)	p value (student t test)
Baumann angle loss	5.56±1.80	5.16±2.64	0.535
MD angle loss	2.44±1.22	2.40±1.32	0.912

fixation, 72 % were considered excellent and 28% good results, while similar results were found in patient with 2-lateral-pin fixation group. Using Flynn's criteria for functional outcome, in two crossed-pin fixation group 20% were excellent, 56% good, 20% fair and 4% poor results while in patients treated with 2-lateral-pin fixations 20% excellent, 48% good, 28% fair and 4% poor results.

One (4%) iatrogenic ulnar nerve injury occurred with two crossed- pin fixation. The iatrogenic ulnar nerve injury between the medial-lateral crossed pin fixation group and the 2-lateral pin fixation group was analyzed using the crossed table method and Fisher's exact test. The p value was 0.312. Hence, there was no significant difference in the frequency of ulnar nerve injury between the two groups of patients. Neither of the patients developed cubitus varus deformity with any of the procedures.

DISCUSSION:

Closed reduction and percutaneous pin fixation is the treatment of choice for displaced extension supracondylar fractures of the humerus in children, although controversy persists regarding the optimal pin-fixation technique.[8,9] Medial – Lateral crossed pins fixation was the gold standard. It provides greater stability but it places the ulnar nerve at risk.[10,11] Two well-placed lateral pins either two parallel or two crossed pins engaging medial cortex provide sufficient stability with lowest risk of iatrogenic ulnar nerve injury.[8,12] Current interest is mainly focused on the pin configuration for fixation that provides adequate stability with the lowest risk of iatrogenic ulnar nerve injury. In our study, no significant difference was found in terms of loss of reduction, the Baumann angle, carrying angle, between the two primary treatment methods involving use of either crossed medial - lateral or two lateral pins fixation.

The outcome of supracondylar humeral fractures in the pediatric population has been commonly assessed by clinical and radiographic parameters, including the Baumann angle and Metaphyseal-Diaphyseal angle of the humerus. Baumann angle of the humerus is a highly reliable measurement, with excellent inter-observer and intra-observer reliability values (r=0.78 and r=0.80, respectively). In most instances, measurements of the Baumann angle of the humerus were within 7° of each other. Therefore, a difference of up to 7° in the measurement of the Baumann angle should be considered within the normal error of the measurement.[13] Aronson et al evaluated the quality of reduction by measuring the Baumann angle after reduction. They accepted the reduction if the Baumann angle of the fractured extremity was within 4 degrees of that of the normal extremity.[14]

Zenios et al determined and quantified intraoperative rotational stability of lateral-entry wire fixation in type-III supracondylar humeral fractures in children. Twenty-one consecutive patients were surgically treated according to a predetermined protocol. After closed fracture reduction, 2 lateral-entry wires were inserted under radiographic control. Stability was then assessed by comparing lateral fluoroscopic images in internal and external rotation. If the fracture remained rotationally unstable, a third lateral-entry wire was inserted, and images were repeated. A medial wire was used only if instability was demonstrated after the insertion of 3 lateral wires. Rotational stability was achieved with 2 lateral-entry wires in 6 cases, 3 lateral-entry wires in 10 cases, and with an additional medial wire in 5 cases. When compared the results with a control group of patients treated at the same hospital before the introduction of this protocol, no patient required a reoperation after the introduction of protocol as opposed to 6 patients in the control group. On analysis of radiographs, the protocol resulted in significantly less fracture position loss as evidenced by change in Baumann angle ($p< 0.05$) and lateral rotational percentage ($p < 0.05$). He concluded that supracondylar fractures that are rotationally stable intraoperatively after wire fixation are unlikely to displace postoperatively.[15]

All pinning techniques were assessed for stability of osteosynthesis in extension, internal and external rotation, varus and valgus stress. Zionts et al analyzed the most stable K-wire configuration for supracondylar humerus fracture osteosynthesis in human cadaver models. After osteosynthesis of fracture, torsional forces were applied to elbow in

10 degree flexion position in multiple direction to find best pin configuration. Best configuration was crossly inserted one medial and one lateral pin. Lateral two crossed pins and lateral two parallel pins followed it, respectively.[16]

A biomechanical comparison of all pin configurations was performed by Lee et al. In extension, varus, valgus, internal and external rotation using a pediatric synthetic bone model.[17] Divergent configuration laterally to prevent ulnar nerve palsy had enough stability but in axial rotation testing, this type of configuration had less stability than the other configurations. In this study divergent pins provide more stability than crossed pin in extension and varus testing. Topping et al found no significant differences in early and late postoperative Baumann's angle between crossed-pin group and lateral pin group. Enough stability was achieved with laterally placed parallel pins for fracture reduction.[18] Even though biomechanical superiority of crossed pinning medial with one or two lateral pin, Bülbül et al preferred two parallel lateral-only-pin configuration to compare the stability. Clinical and functional outcomes showed no difference between two parallel lateral pins versus two parallel lateral and one medial pinning.[19]

CONCLUSIONS:

Radiological analysis showed that both techniques were effective. The 2 lateral pin fixation was as effective as crossed-pins fixation in terms of stability in displaced pediatric supracondylar humerus fractures. One patient developed iatrogenic ulnar nerve injury in two crossed-pin configuration group. No patient developed cubitus varus deformity in either group. The 2- lateral -pin configuration was safe procedure and had less complication.

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