



Original Article

Lateral Pinning for Supracondylar Humerus Fracture in Children: Does The Entry Point of the Pins have an Influence on the Outcome of the Fracture Fixation?

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Abstract

Introduction: Closed reduction with percutaneous pin fixation remains mainstay treatment for displaced supracondylar fractures. Because of documented iatrogenic ulnar nerve injury from medial pin, predilection for placement of lateral pins exist. There has been wide variation in actual starting points. Some studies favour direct lateral epicondyle, extra-articular entry, whereas others advocate capitellar or paraolecranon starting point. We studied the influence of entry point in lateral pinning on the outcome of fractures.

Materials and Methods: We studied 100 patients of Gartland type-3 supracondylar fracture humerus in children treated between March-2014 to March-2017. Patients were divided into two groups of 50 each based on K-wire entry. Group-1 included cases with direct lateral epicondyle entry and group-2 included those with capitellar entry. Radiographic outcomes were assessed based on change in Baumann angle, humerocapitellar angle. The functional results were graded as per Flynn's criteria.

Results: There was no statistically significant difference between the groups with respect to immediate post-operative Baumann and humerocapitellar angle. But at 4wks follow up group-2 patients showed significantly better Baumann, Humerocapitellar angle ($p < 0.005$). Mean carrying angle at final follow up was 3.4 in group-1 and 7.8 in group-2. As per Flynn criteria, 31 of 50 patients in group-1 had good to excellent results and 46 of 50 patients had good to excellent results.

Discussion: Patients in group-2 with capitellar entry of K-wires showed lesser loss of reduction, significantly better elbow range of motion and carrying angle than those with direct lateral K-wire entry. This is due to the fact that the capitellum acts as a middle column and a wire through it specifically maximizes the spread across the fracture site and engages sufficient bone in both proximal and distal fragments.

Conclusion: The capitellar starting point has stiffer construct compared with direct lateral construct hence lesser chances of loss of reduction, malunion and gives good to excellent functional outcome.

Keywords: Supracondylar, Fracture, humerus, Pinning.

Introduction

Supracondylar fracture of the humerus is the most common fracture around the elbow in children and it accounts to 65% of all fractures around the elbow^[1]. When left untreated or improperly treated it is known to cause permanent cosmetic and functional disabilities. Gartland classified it into 3 main categories^[2]. Type-1 and some type-2 fractures are treated conservatively by a plaster slab or cast. Most type-2 and all type-3 fractures are treated by closed/open reduction and K-wire fixation^[3]. Other treatment options are plate/screw fixation, external fixation and so on. Although closed manipulation and percutaneous K-wire stabilization is the gold standard for displaced supracondylar fractures of the humerus in children, optimal pin configuration is still not clear^[1,4-7].

Biomechanical studies have shown that crossed pinning (medial and lateral) provide a more stable configuration especially against torsional loading^[8,9,10], but use of a medial pin is associated with a higher incidence of iatrogenic ulnar nerve injury (6%-12%)^[6,7,9,11,12]. Several studies have tried to address the issue of lateral pin placement in the treatment of supracondylar fractures in children^[4,6,7,8,13-18]. Clinical studies have shown that double lateral pinning alone is of equal stability when compared with crossed pins for the majority of clinical fracture scenarios^[6,12]. Although some clinical studies have recommended maximum spread between divergent pins at the fracture to optimize stability^[9,14,19], but the literature is scant regarding the optimum entry point for the lateral pinning for the supracondylar humerus fracture to obtain maximum stability. Some biomechanical studies favor direct lateral epicondyle, extra-articular entry^[4,5], whereas others advocate capitellar or paraolecranon starting point^[7,9,12]. So we decided to analyze our cases of supracondylar fracture humerus in children to resolve the basic question of: Does the entry point of the pins placed laterally have an influence on the outcome of the supracondylar humerus fracture?

Materials and Methods

We retrospectively analyzed 100 children with supracondylar fracture humerus treated between March-2014 to March-2017. Children between the ages of 4-12 years were included in the study. Only Gartland type-3 fractures were taken into account for the current study. Fractures which were fixed with 2 lateral K-wires were part of the study. Open fractures, Gartland type-1&2, Gartland type-3 fractures which were fixed with 1 or more than 2 K-wires, cases which required open reduction of the fracture, cases with less than 12 months follow up were excluded from the study. The cases were selected based on the inclusion and exclusion criteria from our data registry and were divided into two demographically matched groups of 50 each based on the entry point taken for the K-wire insertion in the lateral condyle. In Group-1 cases with direct lateral epicondyle entry were included and in group-2 those with capitellar entry were included. All cases were treated surgically as an emergency basis under general anaesthesia. The patients were operated on a regular orthopaedic table with a side arm support. After painting and draping the surgical site, the fracture was reduced by a sustained traction and counter-traction for about 2-3 minutes followed by correction of the medio-lateral displacement followed by correction of the posterior displacement and hyper flexion with pronation or supination of the forearm to lock the fracture reduction. In case the proximal fragment has pierced the brachialis muscle the fragment had to be milked out to achieve the fracture reduction. Then the fracture were stabilized with 2 K-wires. In patients in Group-1, the pins were inserted through the lateral epicondyle and in Group-2 patients at least one K-wire was passed through the capitellar/para-olecranon region under C-arm control. Few cases required a third wire for additional stability but such cases were not included in the study. All cases were immobilized in above elbow plaster slab for a period of 3 weeks. At the end of 3 weeks K-wires were removed as an outpatient procedure. After which

the plaster slab was removed and the elbow was mobilized. After which the patients were followed up monthly for next 3 months and once in 3 months for next 1 year and then once in 6 months thereafter. At each follow up patients were clinically and radiologically assessed. Clinical evaluation included assessment of the carrying angle, measurement of the active and passive range of elbow motion, neurologic and vascular examination of the extremity, and determination of any complications such as superficial infection, deep infection, and the need for a reoperation. The clinical results were graded according to the criteria of Flynn et al.,^[20] which are based on the carrying angle and elbow motion. Radiographic evaluation included an anteroposterior radiograph and a lateral radiograph of the elbow. Radiographs were made immediately after pin fixation and at the three to four-week and three-month follow-up visits. The Baumann angle was calculated on the anteroposterior radiograph at each follow up, and the change in the Baumann angle between the immediate post-operative X-ray and the X-ray at 1 month follow up. The humerocapitellar angle was calculated on the lateral radiograph at each follow up, and the change in the humerocapitellar angle between the immediate post-operative X-ray and the X-ray at 1 month follow up and the three-month postoperative radiograph was also recorded.

Results were expressed as mean values \pm standard deviation (SD) or median value if appropriate. Categorical data were compared using chi-square analysis, and for continuous data, *t*-test analysis was used using SPSS Software. Results were considered significant if $P < 0.05$.

Results

This is a retrospective analysis of 100 cases of Gartland type-3 fractures with respect to entry point for lateral pinning after closed reduction of the fracture. Patients in Group-1 and Group-2 were demographically identical. Baumann angles on immediate post-operative AP radiographs were compared with angles on radiographs taken at

approximately 3 to 4 weeks postoperatively. Mean Baumann angle in Group-1 was 74.1 degrees (range, 71.3-78.1 degrees) immediately after surgery and 86.4 degrees (range, 79.8-91.9 degrees) at 4 weeks follow-up. The greatest difference between perioperative and final Baumann angles was 14.4 degrees in Group-1 and this difference was statistically significant ($P < 0.005$). In Group-2 patients the mean Baumann angle measured at immediate postoperative period was 73.6 degrees (range, 70.8-76.9 degrees) and the mean Baumann angle at the 4 week follow-up was 76.8 degrees (range, 72.6-79.9 degrees). This difference was statistically insignificant ($P: 0.68$). The greatest difference between perioperative and final Baumann angles was 4.8 degrees in Group-2, and the difference was statistically insignificant.

Similarly, Humerocapitellar angles on immediate post-operative AP radiographs were compared with angles on radiographs taken at approximately 4 weeks postoperatively. In Group-1, the mean lateral humerocapitellar angle was 38.7 degrees (range, 35.3-44.6 degrees) immediately after surgery and 48.5 degrees (range, 42.2-52.8 degrees) at 4 week follow-up. The greatest difference between perioperative and final Humerocapitellar angle was 12.4 degrees in Group-1 and this difference was statistically significant ($P < 0.005$). In Group-2 the mean humerocapitellar angle measured immediately postoperatively was 37.2 degrees (range, 33.1-41.7 degrees) and the humerocapitellar angle at 4 weeks follow-up was 39.6 (range, 35.0-43.5 degrees). The greatest difference between perioperative and final Humerocapitellar angles was 3.8 degrees in Group-2,

And the difference was statistically insignificant ($P: 0.66$). Mean carrying angle at final follow up was 3.4 in group-1 and 8.8 in group-2. No patients in Group-2 had significant cubitus varus or hyperextension at the elbow. The mean elbow range of motion in Group-1 was from -6 to 108 degrees and in Group-2 was from -3 to 122 degrees. According to the Flynn criteria, in

Group-1, 14 patients had excellent results, 13 patients had good, 7 patients had fair and 6 patients had poor results. In Group-2, 36 patients had excellent results, 12 had good, 2 had fair and no patient had poor results.

Discussion

Obtaining an anatomical reduction, safely maintaining the reduction, and avoiding angular deformities are the goals of treatment of displaced pediatric supracondylar humerus fractures^[3]. This is most often accomplished with closed reduction and percutaneous pinning. Despite a dramatic reduction in fracture malunion as a result of improved reduction and pinning techniques, loss of reduction and angular deformity may still occur. Reasons for this include a less than anatomical initial reduction, less than adequate fixation, and technical errors in pin placement^[12,19]. Treatment of displaced supracondylar humerus fractures with only 2 lateral pins has also been noted to be associated with a higher incidence of loss of reduction^[6,12]. Recommendations to prevent loss of reduction include engaging sufficient bone in both the proximal segment and distal fragment, ensuring maximal pin separation at the fracture site, and placing a third lateral pin if there is a concern about fracture stability^[11,14,15].

The results of the current study demonstrate that the fractures which were fixed with 2 lateral pins from the lateral epicondylar area showed good reduction immediate post-operatively but showed loss of reduction at 4 weeks follow up which was statistically significant. Whereas, those fixed with lateral pins with atleast one pin through the capitellum showed no significant loss of reduction between the radiographs taken immediate post-operative period and at 4 weeks follow up. The loss of reduction was measured by the difference in Baumann and Humero capitellar angle taken at immediate post-operative period and at 4 weeks follow up. Due to which the patients in Group-1 had more incidence of cubitus varus, lesser carrying angle, more chances of hyperextension at

elbow and lesser mean range of motion of the elbow as compared to the patients in Group-2. Because of all these factors the only 27 of the 50 patients in Group-1 showed good to excellent results, whereas in Group-2, 48 of the 50 patients had good to excellent results according to the Flynn's criteria^[20].

The goals for treatment of supracondylar fractures are to obtain stable fixation that allows healing without displacement and to avoid iatrogenic nerve injury during the pin placement. Double lateral divergent pin techniques are more popular, as several clinical studies have shown similar results compared with crossed pins without the risk of ulnar nerve injury.

Loss of fixation in lateral divergent pinning in most cases is due to technical errors in pin placement. Sankar et al analyzed 8 supracondylar humeral fractures that lost reduction^[19]. They reported that in all the cases, loss of reduction was due to identifiable errors on the intraoperative fluoroscopic images and classified them in to 3 types: (1) failure to engage both fragments with 2 pins or more, (2) failure to achieve bicortical fixation with 2 pins or more, and (3) failure to achieve adequate pin separation (>2 mm) at the fracture site. These errors could be prevented with proper technique and pin placement. Although some studies recommend maximizing pin separation at the fracture site, precise lateral pin placement has not been previously standardized^[11,14,15].

Our study showed an increase in construct stiffness with a more capitellar starting point and hence a lesser loss of reduction. By starting within the capitellar anlage, several advantages are provided: (1) ability to engage sufficient bone of the distal fragment, (2) maximize separation of the pins at the fracture site, and (3) allow sufficient room for the placement of a third lateral pin, if warranted.

There were no cases of superficial/deep infections, myositis ossificans in our study and also no cases had K-wire loosening/ back out.

There were a few limitations of our study. We did not analyse the construct stiffness biomechanically and a radiological loss of reduction was considered as lesser stiff construct. Lastly, cases with 3 K-wires were not take into consideration, which could have reduced chances of redisplacement in patients in Group-2.

Conclusion

Patients in group-2 with capitellar entry of K-wires showed lesser loss of reduction, significantly better elbow range of motion and carrying angle than those with direct lateral K-wire entry. This is due to the fact that the capitellum acts as a middle column and a wire through it specifically maximizes the spread across the fracture site and engages sufficient bone in both proximal and distal fragments.

The capitellar starting point has stiffer construct compared with direct lateral construct hence lesser chances of loss of reduction, malunion and gives good to excellent functional outcome.

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