FUNCTIONAL OUTCOME OF PERCUTANEOUS TRANSOLECRANON AND LATERAL KIRSCHNER WIRE FIXATION FOR DISPLACED SUPRACONDYLAR FRACTURE OF HUMERUS IN CHILDREN

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ABSTRACT

Background: Supracondylar fracture of the humerus is one of the most common fractures occurring in children. When the patients present with swelling of the elbow, there is a dilemma whether to wait for the swelling to subside or to perform closed reduction and percutaneous pinning immediately. The objective of this study was to assess the functional outcome of percutaneous transolecranon and lateral K wire fixation and to observe the outcomes associated with this K wire configuration.

Methods: This was a prospective observational study done between 2021 and 2022 at Chitwan Medical College, Nepal. The study included 40 children with closed Gartland type II and III supracondylar fracture of the humerus with no neurovascular injury. They were treated within 3 days with closed reduction and percutaneous pinning using the transolecranon and lateral K-wire fixation technique. The outcome was assessed using the Flynn’s elbow Grading criteria.

Results: At 12 week follow up, 7 (17.5 %) patients had excellent result, 21 (52.5%) patients had good, 8 (20%) patients had fair and 4 (10%) patients had poor result. According to Flynn’s grading system 90 % had satisfactory result and 10 % had unsatisfactory result. Four patients had loss of reduction out of which 2 had poor result and 2 had fair result. None of the patients had post operative iatrogenic ulnar nerve injury.

Conclusions: The percutaneous transolecranon and lateral K-wire fixation for displaced supracondylar fracture of the humerus in children is a good treatment option when the elbow is swollen and is reliable as it prevents iatrogenic ulnar nerve injury.

INTRODUCTION

Supracondylar fracture of humerus is considered to be one of the most common fracture of the elbow in children resulting from fall injury.¹ It is also one of the commonest fractures in children requiring surgery.² Supracondylar humeral fractures are classified as extension type I, II, III and flexion type according to Gartland system.³ The widely accepted treatment for type I fracture is conservative by applying above elbow slab or cast, whereas type II and type III fractures are typically treated by closed reduction and percutaneous pinning.⁴⁻⁶ Different techniques for K-wire insertion have been described in terms of location and configuration of K-wire placement and there is no general consensus in this regard. Crossed pins or lateral pins,⁷ posterior intrafocal pinning technique,⁸ pin leverage technique,⁹ and transarticular guide wire through the olecranon across the fracture site with open reduction of the fracture,¹⁰ are the techniques described in the literature.

Though crossed medial-lateral pin fixation provides increased biomechanical stability, the medial pin can cause iatrogenic ulnar nerve injury.⁷⁻¹¹ In the technique we adopted, we performed the closed reduction and percutaneously inserted a lateral K-wire and added the transolecranon K-wire which is believed to add more stability and at the same time avoids iatrogenic ulnar nerve injury even when there is swelling of the elbow as the olecranon remains palpable.

This study was done to assess the range of motion range of motion (ROM) and carrying angle of the injured elbow and compare it with the uninjured elbow to obtain the ROM loss and carrying angle loss to know the outcome and grade it according to Flynn’s grading criteria.

METHODS

This was a prospective observational study done between September 2021 and August 2022 after getting approval from the ethics committee of the hospital. Patient’s parents consenting to be enrolled in the research was taken up for the study after written informed consent. The inclusion criteria included children aged 2 to 10 years of both sexes and closed Gartland II and III supracondylar fracture. Twenty-nine boys and eleven girls who met the inclusion criteria and presented
within 3 days of injury were included in the study. The exclusion criteria included open fracture, neurovascular injury and intraoperative unreducible fracture leading to open reduction.

All the patients were taken for surgery as early as possible after necessary pre-operative investigations. The procedure was done under general anesthesia with the patient in supine position with the ipsilateral shoulder at the edge of table and the injured elbow on the radiolucent side support. The C arm image intensifier was positioned adjacent and parallel to the table. Traction and counter traction with the elbow in about 30° flexion was applied and the displacement and angulation was corrected. Reduction was checked in the anteroposterior Jone’s view and lateral view with the rotation of the C arm and not by rotating the elbow as this maneuver could displace the reduced fracture. A 2 mm smooth K-wire was then inserted from the lateral side, across the fracture site and purchase obtained on the medial cortex with the elbow in flexion. The elbow was then extended to 90 degree and a small drape bolster was placed under the elbow and the second K-wire was inserted through the olecranon, across the elbow joint through the fracture in to the metaphysis of distal humerus and purchased in the lateral cortex (Figure 1&2). The K-wires were bent about 1 cm from the skin and cut for removal in the clinic after 3 weeks. Sterile dressing was applied and an above elbow back slab was applied with the elbow in about 90 degree of flexion. The operated extremity was elevated for the first 24 hours and observed for post operative complication. X ray was done on the 2nd post operative day and the patient discharged with oral antibiotics.

![Figure 1: Preoperative anteroposterior and lateral X-ray showing Gartland type III fracture](image1)

![Figure 2: Postoperative anteroposterior and lateral X-ray showing transolecranon and lateral K-wire fixation](image2)

![Figure 3: 3 weeks follow up anteroposterior and lateral X-ray showing callus formation](image3)

The patients were followed up in the 1st week for pin site dressing. At 3rd week radiological and clinical assessment was done (Figure 3). The K-wires and the above elbow back slab was removed in the clinic. Arm pouch sling was continued for another one week and active intermittent ROM exercise of elbow flexion and extension was begun. If tenderness was present at the fracture site, the back slab was continued for further one more week. The patients were followed at 6th week and subsequently at 12th week when the patients were assessed for range of motion (ROM) and carrying angle of the injured elbow and the uninjured elbow clinically with a goniometer.

Statistical analysis was performed using IBM SPSS ver. 20. Comparison of range of motion (ROM) was done using the paired t test. A p-value of < 0.05 was considered statistically significant. Carrying angle loss was compared using Wilcoxon signed rank test. The results were graded according the criteria given by Flynn et al as shown in table 1. Grading of the patients who had changes both in the ROM and carrying angle was made on the basis of greater clinical loss component.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Cosmetic factor (carrying angle loss)</th>
<th>Functional factor (range of movement loss)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfactory</td>
<td>0° - 5°</td>
<td>0° - 5°</td>
</tr>
<tr>
<td>Excellent</td>
<td>6° - 10°</td>
<td>6° - 10°</td>
</tr>
<tr>
<td>Good</td>
<td>11° - 15°</td>
<td>11° - 15°</td>
</tr>
<tr>
<td>Fair</td>
<td>&gt;15°</td>
<td>&gt;15°</td>
</tr>
<tr>
<td>Unsatisfactory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td></td>
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</tbody>
</table>

RESULTS

Forty (40) patients who met the inclusion criteria were included in the study. The average age of the children was 6.83±2.12 years (range 3 to 10 years). Twenty-nine (72.5%) of them were males and 11 (27.5%) of them were females. Fourteen (35%) of the children presented with right elbow injury and 26 (65%) of them presented with left elbow injury. Twelve (30%) fractures were Gartland type II and 28 (70%) fractures were Gartland type III.
At 12 weeks follow up, the patients were assessed for flexion, extension, range of motion (ROM) and carrying angle of the injured and uninjured elbow. The observations made is shown in table 2. Valgus deviation from neutral ulnohumeral angle (taken as reference 0°) was given a negative value and varus deviation a positive value. The loss in flexion, extension, ROM and carrying angle of the injured elbow compared to the uninjured elbow is shown in table 3. According to Flynn grading criteria 90 % of patients had satisfactory and 10 % had unsatisfactory outcome as shown in figure 4.

Table 2: District wise distribution of dengue cases

<table>
<thead>
<tr>
<th>Variables</th>
<th>Injured elbow (degrees)</th>
<th>Uninjured elbow (degrees)</th>
<th>p-value**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexion</td>
<td>132.88 ± 5.42</td>
<td>138.13 ± 4.03</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Extension</td>
<td>5.38 ± 3.28</td>
<td>-1.00 ± 2.02*</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>ROM</td>
<td>127.50 ± 6.02</td>
<td>138.62 ± 4.80</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Carrying angle</td>
<td>-5 (-15 to 5)†</td>
<td>-10 (-10 to -5)†</td>
<td></td>
</tr>
</tbody>
</table>

* hyperextension of elbow, † valgus position of elbow, **student’s t-test

At 12 weeks follow up, the patients were assessed for flexion, extension, range of motion (ROM) and carrying angle of the injured and uninjured elbow. The observations made is shown in table 2. Valgus deviation from neutral ulnohumeral angle (taken as reference 0°) was given a negative value and varus deviation a positive value. The loss in flexion, extension, ROM and carrying angle of the injured elbow compared to the uninjured elbow is shown in table 3. According to Flynn grading criteria 90 % of patients had satisfactory and 10 % had unsatisfactory outcome as shown in figure 4.

Table 3: Loss of ROM and carrying angle at 12 weeks follow up

<table>
<thead>
<tr>
<th>Variables</th>
<th>Loss (in degrees) of the injured elbow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexion</td>
<td>4.88 ± 3.67 (0 to 15)</td>
</tr>
<tr>
<td>Extension</td>
<td>5.50 ± 3.54 (0 to 15)</td>
</tr>
<tr>
<td>ROM</td>
<td>11.13 ± 4.99 (5 to 25)</td>
</tr>
<tr>
<td>Carrying angle</td>
<td>4.83 ± 3.73 (0 to 15)</td>
</tr>
</tbody>
</table>

DISCUSSION

The elbow is swollen after supracondylar fracture and it is difficult to palpate the medial epicondyle which is the landmark for inserting the medial K-wire. The olecranon is a much larger structure and is palpable. The transolecranon K-wire can be inserted through the olecranon avoiding injury to the ulnar nerve which lies behind the medial epicondyle. The study by Archibald et al\(^\text{10}\) mentions inserting a single 2.4 mm guide wire through the olecranon, the elbow joint, across the fracture site and in to the humeral shaft. They followed the patients for an average of 6.8 years (range 9 months to 20 years) and obtained excellent to good results in 27 of 34 injured elbows (79% of the patients).

We were quite skeptical using a single K-wire and also used a lateral K-wire for more stable fixation of the fracture in our study. Sharma A et al\(^\text{13}\) and Jindal R C et al\(^\text{14}\) have also advocated using a lateral K-wire in addition to the transolecranon K-wire in their research. Our study group did not include patients with nerve injury or vascular compromise. They were operated at earliest possible time after presenting to us. The study conducted by Sharma A et al\(^\text{13}\) suggests there is no statistically significant difference in functional outcomes in patients operated at various durations but within 5 days of injury.

We observed no immediate post-operative complications like ulnar nerve injury or vascular injury. However, we observed 2 pin tract infection during the 3rd week follow up. The infection resolved after the pins were removed. There was no breakage of K-wires noted in any of the patients. We observed varus deformity in 4 patients.

In the literature there remains the controversy of pin site insertion and the configuration of the pins inserted regarding the treatment of supracondylar fracture of the humerus in children. The technique of one lateral pin and another transolecranon pin is a good option for the treatment of these fractures. The only concern is the K-wire entering the elbow joint but this does not damage the articular cartilage if it is not pierced multiple times.

In our study we did not observe breakage of the transolecranon K-wire or infection of the elbow joint. Archibald et al\(^\text{10}\) who followed the patients for an average of 6.8 years have not reported any complications related to the K-wire entering the elbow joint such as articular cartilage damage or infection of the elbow joint. The K-wires are smooth pins which are used for transolecranon transarticular fixation of fracture so there is no articular cartilage damage.\(^\text{13,14}\) Taking aseptic precaution avoids the risk of infection of the elbow joint. Sharma et al\(^\text{13}\) and Jindal R et al\(^\text{14}\) also have not reported any complications related specifically to the transolecranon K-wire. The transolecranon K-wire limits flexion and extension of the elbow but the elbow is kept in above elbow slab until the K-wires are removed and this prevents K-wire breakeage. The other concern is the chance of K-wire breakeage when the slab is removed for pin
site dressing. This is prevented by taking care not to extend the elbow when the slab is temporarily removed for dressing.

We did not observe any patients with iatrogenic ulnar nerve injury with the transolecranon and lateral K-wire fixation. Sharma A et al \(^{13}\) did not observe any iatrogenic ulnar nerve injury with this similar K-wire configuration. Skaggs DL et al \(^{7}\) in their comparative study of medial-lateral cross pins versus lateral pins observed 17 patients (19%) in the cross-pinning group had ulnar nerve injury. EI-Adl W et al \(^{16}\) performed lateral entry cross K-wire and none of the patients had iatrogenic ulnar nerve palsy.

In the research we observed 4 (10%) patients with loss of reduction. The loss of reduction was due to technical error where the transolecranon K-wire was placed in the medullary canal which did not purchase the cortical bone of the humeral shaft. Jindal R et al \(^{14}\) had 10% cases with loss of reduction and Sharma A et al \(^{15}\) also had 10% loss of reduction with the transolecranon and lateral pinning. Archibald D et al \(^{10}\) had 2.9% loss of reduction due to technical error where the K-wire inserted did not reach the proximal humerus. Devkota P et al \(^{17}\) in their study had 1.96% loss of reduction with cross pinning which they claim that it was not significant and did not require re-pinning. Skaggs D et al \(^{11}\) observed no loss of reduction in their study with either cross pinning or lateral pins. The 4(10%) patients with loss of reduction had varus deformity at 12th week follow up. This was the result of acceptance of the placement of transolecranon K-wire in the medullary canal after satisfactory reduction of the fracture and loss of reduction on subsequent follow up. Sharma A et al \(^{15}\) observed 6.67% cases with cubitus varus deformity. Jindal R et al \(^{14}\) mentioned 10% cases with loss of reduction but reported none of their patients had varus deformity. EI-Adl W et al \(^{16}\) who used the lateral entry cross K-wire observed 8.6% cases with cubitus varus deformity in their study due to unsatisfactory reduction of the fracture. Lee H et al \(^{12}\) used closed reduction and percutaneous pinning using the pin leverage technique observed 53.3% cases with cubitus varus deformity. We encountered 2 (5%) pin tract infection with presence of sprouting tissue around the pin site with no distal migration of the K-wire in our study at 3 week follow up which resolved after the pin were removed and did not result in elbow joint infection. Sharma A et al \(^{15}\) had 3.3% pin tract infection in study which was superficial and did not involve the elbow joint with the transolecranon and lateral K-wires. This K-wire configuration when done with good aseptic condition does not result in elbow joint infection. Devkota P et al \(^{17}\) observed 7.84% and EI-Adl W et al \(^{16}\) observed 8.6% pin tract infection in their studies.

The outcome of our research had 90% satisfactory result and 10% unsatisfactory result according to Flynn’s grading criteria. The observations in our study are similar to the study by Sharma A et al \(^{15}\) who also had 90 % satisfactory result and 10 % unsatisfactory result in 90 patients. Sharma A et al \(^{13}\) in their another study observed 92 % satisfactory and 8 % unsatisfactory result with 50 patients. Whereas Jindal R et al \(^{14}\) in a similar study observed 80% satisfactory and 20% unsatisfactory result with 30 patients. The injured elbow when compared with the uninjured elbow had a flexion loss of 4.88° ± 3.67° which is comparable to the study by Sharma A et al \(^{13}\) in which the flexion loss was 4.45° ± 4.16°. The extension loss observed in our study was 5.50° ± 3.54°, which is more than 1.7° ± 4.32° as obtained by Sharma A et al \(^{13}\). The ROM loss was 11.13° ± 4.99°. The change in carrying angle was 4.83° ± 3.73° which is comparable to that as obtained by Sharma A et al \(^{13}\) which was 3.47° ± 4.70°.

When we considered the carrying angle loss only (cosmetic factor) and not considering the range of motion loss, we had 33 (82.5%) patients with excellent result, 5 (12.5%) patients with good results, 2 (5%) patients with fair result and no patients with poor result. When considering the range of motion loss only (functional factor) 7 (17.5%) patients had excellent results, 21 (52.5%) patients had good results, 8 (20%) patients had fair results and 4 (10%) patients had poor result. In our study we observed that the range of motion loss determined the results for Flynn’s grading rather than the carrying angle loss as the Flynn’s grading criteria takes in to account the greater clinical loss for grading of the result. Out of the 4 patients with varus deformity 2 had fair result and 2 had poor result according Flynn’s grading criteria. We observe that the varus deformity does not necessarily mean poor result. Two of the patients had fair range of motion of the elbow with only 10° loss compared to the uninjured elbow.

This was a single center study with a small sample size. We had a short term follow up. Multicenter studies with a larger sample size and longer follow up is needed to establish this method of percutaneous transolecranon and lateral K-wire fixation for the treatment for displaced supracondylar fracture of humerus in children.

**CONCLUSION**

The percutaneous transolecranon and lateral K-wire fixation for displaced supracondyular fracture of the humerus in children has good to excellent results and can be a treatment option when there is significant swelling of the elbow. This method avoids iatrogenic ulnar nerve injury.

**CONFLICT OF INTEREST:** None

**FINANCIAL DISCLOSURE:** None

**REFERENCES:**


