Treatment approaches and outcomes in childhood supracondylar humerus fractures

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Abstract. – BACKGROUND, Being one of the most frequent elbow fractures during childhood, supracondylar humerus fractures require rapid diagnosis and treatment, as they may be associated with significant neurovascular and functional problems.

QUESTIONS AND PURPOSES, To evaluate demographic and clinical features, and treatment outcomes of the patients with supracondylar humerus fractures who underwent open reduction+minimal osteosynthesis or closed reduction+percutaneous wiring.

PATIENTS AND METHODS, Forty patients (30 boys + 10 girls) between 2 and 13 years of age who were operated on with the diagnosis of supracondylar humerus fracture, between August 2003 and December 2006, were included. Open reduction+minimal osteosynthesis (n=34) and closed reduction+percutaneous wiring (n=6) were performed. The fractures were classified according to the Gartland classification and outcomes were assessed according to Flynn's criteria.

RESULTS, All patients (mean age, 7.35 years; range, 2-13 years) had closed fractures (28 left and 12 right). Seven (17.5%) and 33 (82.5%) patients had Gartland type II and III fractures respectively. Three patients had flexion-type and 37 patients had extension-type fractures. Based on Flynn's criteria, cosmetic results were excellent in 37 (92.5%) patients and good in 3 (7.5%) patients, and functional results were excellent in 36 (90%) patients, good in 3 (7.5%) patients, and poor in 1 (2.5%) patient. A surgical success rate of 97.5% was noted. No significant difference was found between wire configurations (p > 0.05).

CONCLUSIONS, Treatment of supracondylar humerus fractures in children should be patient-specific based on factors such as patient’s age, soft tissue conditions and deformity status.

Key Words:
Childhood, Supracondylar humerus fractures, Surgical approach.

Introduction

Supracondylar humerus fractures are the most common elbow fractures during childhood1,2. These fractures have been reported to constitute nearly 60% of elbow fractures, and 13% of all fractures in pediatric ages3. Most of these fractures occur between 5 and 7 years of age and are more frequent in boys4,5. The frequency decreases after 12 years of age1, and most of the fractures occur in the left or non-dominant side6,7.

Supracondylar humerus fractures are classified as extension and flexion fractures, about 97%-99% of which are extension-type fractures4,8 occurring due to falling on the outstretched upper extremity with the elbow in full extension. While extension-type fractures are classified according to the Gartland classification9, flexion-type fractures are classified according to the degree of displacement10,11. In extension-type injuries, the distal fragment of the fracture may cause compression of the radial nerve. Brachial artery and median nerve may also be injured due to being compressed between fracture fragments in the lateral displacement11. In flexion-type fractures, the distal fragment of the fracture may cause compression and injury of the ulnar nerve.

Forearm fractures accompanying supracondylar fractures increase the risk of compartment syndrome12. Prevalence of vascular involvement in elbow injuries has been reported as 12%-20%10,12,13. Following vascular examination, radial, ulnar, median and anterior interosseous nerves are assessed on neurological examination. Pain, coldness, pallor, cyanosis, or absent pulse in the extremity due to injury induced neurovascular damage might be preliminary signs of compartment syndrome. The next step of assessment involves true anteroposterior radiographic imaging of the distal humerus and true lateral radiographic imaging of the elbow. Fracture line may not al-
ways be visible on radiographic imaging, and “fat-pad sign” may be the only sign of fracture. In the presence of a fracture disrupting bone integrity, two main radiography findings include posterior displacement of the middle third of the capitellum with respect to the anterior humeral line and a decrease in the humeral-capitellar angle (normal range, 9°-26°), known as “Bau mann’s angle”.

The initial management of supracondylar humerus fractures in emergency conditions includes splint immobilization of the upper extremity preserving the appropriate position. Neurovascular control should be performed before and after splint immobilization. Fracture fragments should be reduced if signs of ischemia are noted in the distal part of extremity. Elbow flexion should be avoided to prevent potential neurovascular damage in extension-type fractures. The second and main part of management in non-displaced fractures is three weeks of long-arm cast immobilization. In displaced fractures, however, open or closed reduction can be performed. Cast immobilization, traction, and percutaneous pin fixation can be performed following closed reduction. Open reduction should be performed in the presence of circulatory problems due to fracture fragments, open fracture, failure in closed reduction, accompanying forearm fractures or irreducible fractures.

The present study aimed to evaluate demographic and clinical features, and treatment outcomes of the patients with supracondylar humerus fractures who underwent open reduction + minimal osteosynthesis or closed reduction + percutaneous wiring.

**Materials and Methods**

Forty patients (30 boys and 10 girls) between 2 to 13 years of age who were operated on with the diagnosis of supracondylar humerus fracture between August 2003 and December 2006 were included in the present study. The Gartland classification was used for the classification of fractures. According to this classification, patients who had displaced type II and III supracondylar humeral fractures were treated surgically. Seven patients had type II fractures, 33 had type III. Three patients had flexion type, 37 had extension. All patients were followed up for at least 6 months, and their final assessments were performed.

Surgical incisions used during open surgery included a posterior longitudinal incision extending from the distal humerus to the olecranon, a lateral incision traversing the lateral condyle with a slightly anterior tilt or a medial incision centered over the medial epicondyle. Posterior approach was performed by reaching the fracture line from both of its sides without dissecting the triceps muscle. It was made sure that the ulnar nerve was exposed in this approach, and efforts were made to preserve the radial nerve during lateral incision.

Fracture fragments were reduced through the posterior fracture line by a posterior incision or through the anterior fracture line by lateral or medial incisions. After stabilization by cross fixation using Kirschner wires (K-wires), the tissues were closed as required. The K-wires were bent and left outside the skin. The extremity was then placed in a long-arm splint with the elbow in 90 degrees of flexion. Prophylactic antibiotic treatment was initiated in these patients; the sutures were removed on day 10, weekly radiographic controls were performed and the cast and K-wires were removed depending on union formation after 3-4 weeks of immobilization.

In closed approach, patients were placed in the prone position, and after closed repositioning under scopic control, stabilization was established by cross fixation with K-wires inserted from lateral and medial sides. The K-wires were bent and left outside the skin. The extremity was placed in a long-arm circular cast with the elbow in 90 degrees of flexion. Weekly radiographic controls of these patients were performed, and the cast and K-wires were removed depending on union formation after 3-4 weeks of immobilization.

Following the removal of the splint, both the parents and children were instructed about elbow range of motion (ROM) exercises and asked to continue these exercises at home. Patients with limited elbow ROM at the end of 6-8 weeks despite this program were referred to the Physical Medicine and Rehabilitation Clinic.

Clinical and radiological assessments were performed at the final visit in all patients. Elbow ROM were measured using a standard goniometer. Flexion/extension, pronation/supination motions were evaluated, and limitations were recorded in degrees. Clinical assessment of angular deformity (varus or valgus deformity) was performed by measuring the carrying angles of elbow bilaterally using a goniometer. Anteroposterior and lateral radiographs were obtained for
Cosmetic assessment (change in the carrying angle) | Functional assessment (loss of motion)
---|---
Excellent | 0-5 degrees | 0-5 degrees
Good | 6-10 degrees | 6-10 degrees
Fair | 11-15 degrees | 11-15 degrees
Poor | > 15 degrees | > 16 degrees
in 3 (7.5%) patients, whereas functional results were excellent in 36 (90%) patients, good in 3 (7.5%) patients, and poor in 1 (2.5%) patient. Outcomes of different surgical approaches are presented in Table IV. Considering excellent and good results after surgery as general success rates, a surgical success rate of 97.5% was achieved.

Osteosynthesis was performed by medial and lateral insertion of two crossed K-wires in 21 patients, of them 20 had excellent and 1 had good outcomes. Osteosynthesis was performed by 2 laterally and 1 medially inserted crossed K-wires in 11 patients; 10 had excellent and 1 had poor outcomes. Osteosynthesis was performed by 1 laterally and 1 medially inserted crossed K-wires in 6 patients; outcome was excellent in 5 patients and good in 1 patient. In 1 patient, osteosynthesis was performed by lateral insertion of 2 parallel K-wires and outcome was good. Osteosynthesis was performed by 2 laterally and 2 medially inserted K-wires in 1 patient with a good outcome. No significant difference was found between wire configurations used ($p > 0.05$).

**Discussion**

Supracondylar humerus fractures are commonly seen during childhood and constitute nearly 60% of elbow fractures in pediatric age group. These fractures are of special clinical significance as they may lead to neurovascular damage and morphological deformities. It has been reported in various series that these fractures are most common between 2 and 12 years of age and are more frequent in boys, and the left side is more commonly affected compared to the right side. Various physical force-response mechanisms such as tendency toward hyperextension due to ligamentous laxity in the juvenile age group, characteristics of bone structure in the supracondylar region, and relationship of joint structures in hyperextension have been suggested to be responsible for the higher frequency of supracondylar humerus fractures in the first decade of life. Most frequent etiological factors for supracondylar humeral fractures have been reported as simple falls, falling from high, and accidents. Extension-type fracture has been reported as the most common fracture type as 95% of the supracondylar humeral fractures are extension-type fractures. Demographic features of the patients, etiological factors and morphological characteristics of the fractures in the present study were noted to be similar to those reported in the above-mentioned studies.

The main goal in the management of childhood supracondylar humerus fractures is to obtain the best functional and morphological outcome with the least number of complications. Although a consensus has been reached among Authors on the treatment approach to non-displaced fractures, various treatment approaches that are currently being argued have been suggested for displaced fractures. Closed reduction + casting, which is one of these approaches, has been reported be associated with the worst outcomes as

<table>
<thead>
<tr>
<th>Surgical approach</th>
<th>Excellent n (%)</th>
<th>Good n (%)</th>
<th>Fair n (%)</th>
<th>Poor n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral</td>
<td>21 (84)</td>
<td>3 (12)</td>
<td>–</td>
<td>1 (4)</td>
</tr>
<tr>
<td>Posterior</td>
<td>5 (83.3)</td>
<td>1 (16.7)</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Medial</td>
<td>2 (100)</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Lateral + medial</td>
<td>1 (100)</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Closed</td>
<td>6 (100)</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Total</td>
<td>35 (87.5)</td>
<td>4 (10)</td>
<td>–</td>
<td>1 (2.5)</td>
</tr>
</tbody>
</table>

**Table IV.** Outcomes of different surgical approaches.
compared to other modalities. Closed reduction and osteosynthesis with percutaneous wiring is another method which has been shown to be associated with favorable outcomes in the management of supracondylar humeral fractures. Success rates ranging from 67% to 91.8% have been reported with this technique in different series. Greater controversy exists regarding open reduction and internal fixation, which is another surgical treatment alternative. While some authors suggest that this method should be the first choice of treatment, others argue that it should be performed in patients in whom treatment with closed reduction fails. In the present study, we achieved excellent results in all 6 patients treated with closed reduction and percutaneous wiring, and in 85.3% of 34 patients treated with open reduction and internal fixation; these high success rates were in parallel with the results previously reported for these methods.

There is no consensus regarding the type of surgical incisions to be used during open reduction procedures. Although successful outcomes have been reported using anterior, medial, and posterior incisions, no statistically significant differences have been found between these approaches. Similar to these findings, we did not find any significant clinical and radiological differences between surgical incisions.

In biomechanical studies comparing different wire configurations used for osteosynthesis in the management of supracondylar humeral fractures, it has been found that medial and laterally inserted crossed Kirschner wire model is the most stable configuration. However, it should be noted that dissection should be performed before medial placement of these wires to avoid iatrogenic ulnar nerve injury. In the present study, we did not observe any complications associated with any wire configurations, and no statistically significant difference was noted between the success rates of different methods.

Conclusions

In conclusion, demographic and clinical features of our study population as well as treatment outcomes associated with surgical techniques that we used were noted to be similar to those reported previously. Treatment of supracondylar humeral fractures should be patient-specific; treatment should be decided based on the factors such as patient’s age, soft tissue conditions and deformity status. Closed reduction and fixation by percutaneous wiring provides an effective and safe treatment for these fractures. However, in the presence of open fractures or neurological or vascular pathologies accompanying the fracture and if treatment by closed repositioning fails, open reduction and osteosynthesis with internal fixation should be performed.

References

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