

Original Article

Comparison of Medial and Posterior Surgical Approaches in Pediatric Supracondylar Humerus Fractures

E Şahin, S Zehir¹, S Sipahioglu²

Department of Orthopedics and Traumatology, Faculty of Medicine, Bülent Ecevit University, Zonguldak,

¹Department of Orthopedics and Traumatology, Faculty of Medicine, Hitit University, Çorum, ²Department of Orthopedics and Traumatology, Faculty of Medicine, Harran University, Şanlıurfa, Turkey

ABSTRACT

Objectives: The aim of the current study was to compare the clinical results of pediatric supracondylar humerus fracture cases requiring open reduction through medial approach with posterior approach. **Patients and Methods:** Retrospective cohort of 67 cases of pediatric supracondylar fractures was reviewed. Thirty-three patients (20 males, 13 female, average age: 8.3 ± 3.131) were treated with medial approach were compared with 34 patients (19 males, 15 females, average age: 7.5 ± 3.146) treated with posterior exposure. Median follow-up period of the first group was 35.04 months (range: 17–76 months) and of the second group was 36.04 (range: 16–65 months). Radiological evaluation included Baumann angle, carrying angles, and lateral humero-capitellar angles. Functional and cosmetic evaluation was assessed with range-of-motion measurements and the criteria defined by Flynn *et al.* **Results:** No differences between groups were noted regarding gender, age, and follow-up periods. Operative time was significantly shorter in medial approach group [60.0 ± 14.5 vs. 75.8 ± 17.6 min ($P = 0.002$)]. Radiological measurements (Baumann, humero-capitellar, and carrying angles) were also similar between groups. When evaluated patients according to Flynn's criteria, for medial group, 31 cases (93.9%) had good–perfect result regarding ROM loss, whereas for posterior group 33 cases (97%) had good–perfect result. Regarding carrying angle change and posterior group were slightly better than medial group (perfect result observed in 91.1% vs 81.8%, respectively). The differences did not show statistical significance. **Conclusion:** In the treatment of supracondylar humerus fractures in children, both surgical approaches revealed similar functional and radiological outcomes with shorter operative time when medial approach was utilized.

KEYWORDS: Children, humerus, supracondylar fracture

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INTRODUCTION

Supracondylar humerus fractures are the most common fractures comprising 50-70% of upper extremity fractures in the pediatric population aged 3-10 years old.^[1] Most of these fractures have been reported to require surgical fixation in children.^[2]

Although many methods have been described for the treatment of displaced fractures, closed reduction and percutaneous pinning has been accepted as the gold standard treatment method.^[3-5] However, open reduction is indicated if fracture cannot be reduced with a closed approach or reduction is unsatisfactory, or is an open fracture, or vascular injury is present.^[1,6,7]

The approach for open reduction remains a matter of debate. Anterior, medial, lateral, posterior, and double incisions (medial and lateral) have all been used and recommended in the literature.^[8-10] Theoretical advantage of medial approach is better restoration of rotation and medial columnar alignment by direct vision and avoidance of ulnar nerve during medial KW placement.^[12,13] Advantage of posterior approach can be accepted as a

Address for correspondence:

Dr. E Şahin,
Department of Orthopedics and Traumatology, Faculty of
Medicine, Bülent Ecevit University, Zonguldak, Turkey.
E-mail: dr_erc_sah@yahoo.com.tr

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relatively straightforward approach for fracture reduction with minimal neurovascular dissection.

The aim of the current study was to compare the functional and radiological results of pediatric supracondylar humerus fracture cases necessitating open reduction performed with either the medial approach or the posterior approach.

PATIENTS AND METHODS

A retrospective analysis was made of the hospital data of children with displaced extension-type (Type III Gartland Classification)^[6] supracondylar fractures of the humerus who were admitted to our Emergency Department between April 2007 and September 2012. Exclusion criteria were defined as open fractures, flexion type fractures, multiple trauma cases and accompanying neurological or vascular injuries, and cases of which reduction was achieved by closed methods. From total of 136 patients, 70 children with supracondylar fractures of the humerus were defined as the study group and invited for follow-up evaluation. Out of 70 cases, 67 cases were admitted for follow-up evaluation.

Closed reduction under general anesthesia and crossed pins wire fixation was initially attempted for all type III supracondylar fractures of the humerus. In cases of inadequate reduction, open reduction and crossed pins wire fixation was applied with either a medial or posterior approach.

Two different surgical approaches (medial and posterior) were used by two surgeons with at least 5 years of trauma surgery experience. Study group were divided into groups based on these approaches.

Group 1 ($n = 33$; M/F = 1.54) was defined for the medial approach cases and Group 2 ($n = 34$; M/F = 1.26) was defined for posterior approach cases. The mean age of the children was 8.3 ± 3.131 years (range, 3-13 years) in Group 1 and 7.5 ± 3.146 years (range, 2-13 years) in Group 2. All the children were operated within 24 hours of the injury.

The mean follow-up period at the time of final evaluation was 35.04 months (range, 17-76 months) in Group 1 and 36.04 months (range, 16-65 months) in Group 2.

Surgical approach

All operations were performed in a single-center institution by two experienced trauma surgeons. In Group 1, with the medial approach, the supine position was preferred. A 5-6 cm longitudinal incision was made over the medial side of the distal end of the humerus and elbow. The ulnar nerve was located and protected throughout the operation. A medial K-wire was applied after ensuring medial column continuity following reduction. Lateral K-wire fixation was applied through the lateral epicondyle under fluoroscopy guidance after anatomic reduction was

achieved. Extralateral incisions were not needed in any of the children to obtain anatomic reduction.

In Group 2, with the posterior approach, the supine position was also used. A midline 5-6 cm longitudinal incision was made extending over the elbow and the distal end of the humerus. The ulnar nerve was identified and carefully mobilized. The aponeurosis of the triceps was exposed completely and was freed proximally-to-distally in a reverse V or tongue-shaped flap.^[14] The flap was retracted distally for clear exposure of the fracture line. Fixation was made with two crossed K-wires following reduction [Figure 1]. Two crossed pins, one from the medial side, and the other from the lateral side, were inserted, and fracture stability was ensured clinically and radiologically with fluoroscopy. Duration of surgery was also recorded in all patients.

Follow-up and evaluation

In all patients, a long-arm cast was applied for 3 weeks, and range-of-motion (ROM) exercises were started while the pins remained. The K-wires were removed when sufficient callus was observed radiologically (usually around 6th week postoperatively). All the patients followed a home care ROM exercise program, and children who failed to achieve full ROM postoperatively 3rd month were referred to physical therapist.

All patients were invited for final follow-up evaluation (35.04 months for group 1 and 36.04 months for group 2 postoperatively). At the final visit, all cases were evaluated functionally and radiologically. Coronal plane alignment was evaluated with change in Baumann angle, whereas sagittal plane alignment was assessed radiologically by change in lateral humero-capitellar angle (compared to uninvolved elbow). Degree of carrying angle loss and loss of ROM in comparison with the contralateral elbow were also recorded at the final visit. ROM and carrying angle were measured by goniometry. The grading system defined by Flynn *et al.*^[15] was used to assess the functional results of treatment [Table 1].

The statistical analysis in this study was performed with the Statistical Package for Social Sciences (SPSS) software program, version 17 for Windows. The chi-square and independent *t*-tests were used for the comparison of data. A value of $P < 0.05$ was accepted as statistically significant.

RESULTS

There was no significant difference between the two groups regarding gender, age, or follow-up duration. The mean operative time was 75.8 ± 17.6 min in the posterior approach group and 60.0 ± 14.5 min in the medial

approach group. The difference between operative times was statistically significant ($P = 0.002$).

No early and late complications such as iatrogenic neurovascular injury, pin tract infection, myositis ossificans, compartment syndrome, or delayed union were observed in either intervention group.

At the final visit, compared to uninvolved elbow mean limitation of motion was 2.61 ± 3.64 in the medial approach group and 3.33 ± 4.28 in the posterior approach group. The difference between groups did not reach statistical significance.

The Baumann angle was measured as 81 ± 5.89 in group 1 and 79 ± 4.18 in group 2 ($P = 0.27$). Similarly, in humero-capitellar angle (compared to uninvolved elbow) was measured as $39.5 \pm 4.6^\circ$ in group 1 and 41.7 ± 3.7

in group 2 ($P = 0.78$). The difference of radiological evaluation parameters was not significant.

Decrease in carrying angle (clinically= on extended elbow) was 3.7 (range: 0-16, SD: 3.17) in group 1 and 4.1 degrees (range: 0-6, SD: 2.32) in group 2 ($P = 0.89$). Clinically noticeable ROM limitation was observed in 11 children (33.3%) in the medial approach group and in 15 children (44%) in the posterior approach group. The mean limitation of motion was 2.61 in the medial approach group and 3.33 in the posterior approach group. There was no statistically significant difference between the two approach groups regarding motion loss. When ROM loss was categorized according to criteria defined by Flynn *et al.* Thirty-one cases from group 1 (93.9 %) and 33 cases from group 2 (97%) demonstrated good-perfect result [Table 2]. When ROM scores were assessed according to the Flynn criteria, 29 (87.8%) children had perfect scores, 2 (6.06%) children had good scores, 1 (3.03%) child had a fair score, and 1 (3.03%) child had a bad score in the medial approach group. Similarly, in the posterior approach group, 29 (85.3%) children had perfect scores, 4 (11.8%) had good scores, and 1 (2.9%) had a bad score. Cosmetic scores according to the Flynn criteria, which was consisted of loss of carrying angle

Table 1: Flynn *et al.* criteria

	Functional ROM loss (°)	Cosmetic Carrying angle change (°)
Perfect	0–5	0–5
Good	6–10	6–10
Fair	11–15	11–15
Bad	>15	>15

Table 2: Patient distribution according to the Flynn criteria

	Perfect	Good	Fair	Bad
Functional+ ROM loss (°)	0–5	6–10	11–15	>15
Medial	29 (87.8%)	2 (6.06%)	1 (3.03%)	1 (3.03%)
Posterior	29 (85.3%)	4 (11.8%)	-	1 (2.9%)
Cosmetic Carrying angle change (°)	0–5	6–10	11–15	>15
Medial	27 (81.8%)	6 (18.2%)	-	-
Posterior	31 (91.1%)	3 (8.9%)	-	-

Table 3: Evaluation of pediatric supracondylar fractures in the literature

Author	Exposure	Perfect-good functional results	Perfect-good cosmetic results
Barlas K	Medial	95.4%	90.7%
Eren A	Medial	100%	100%
	Lateral	95%	100%
Ekşioğlu F	Posterior	79.06%	81.39%
	Closed	80.95%	80.94%
Aktekin CN	Posterior	52%	74%
	Closed	91%	91%
Bombacı H	Posterior	80%	100%
	Lateral	76.47%	94.11%
Bamrungthin N	Posterior	80.7%	84.6%
	Lateral	80%	80%
Gürkan V	Posterior	85.7%	96.9%
Our study	Posterior	97.1%	100%
	Medial	93.8%	100%

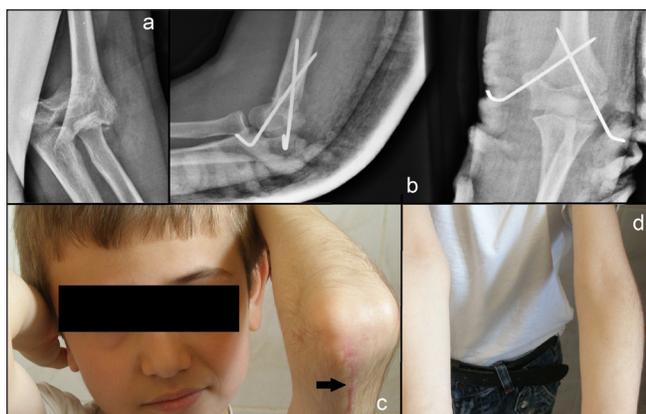


Figure 1: A 7-year-old boy admitted to the emergency department with complaints of pain, swelling and deformity at left elbow following fall on left arm. X-ray reveals Gartland type-3 left supracondylar fracture (a) Postoperative lateral and A-P (b) radiographs following open reduction via posterior approach and fixation with two crossed percutaneous Kirschner wires. At third week postoperatively, photo showing flexion (c) and extension (d) ranges. Arrow shows incision site

were observed as excellent in 27 (81.8%) and good in 6 (18.2%) cases in the medial approach group; and excellent in 31 (91.1%), and good in 3 (8.9%) case in the posterior approach group [Table 2]. There was a minimal trend towards better restoration of carrying angle with posterior approach, however, this observation did not reach statistical significance.

DISCUSSION

Although there are numerous studies regarding approach type in pediatric supracondylar humerus fractures, there is scarcity of evidence regarding the type of approach and incision to be chosen in type 3 fractures necessitating open reduction. Several outcome studies have been published comparing different approaches [Table 3].

Regarding operation time; Bombacı *et al.* compared results of posterior approach and lateral approach in type 3 fractures.^[16] They observed approximately 15-min shorter duration of operation with lateral approach. Conversely, Bamrunghthin *et al.* reported a shorter duration of operation (approximately 4 min) with posterior approach.^[17] In our study, mean operation duration was 75.8 ± 17.6 min in the posterior approach group and 60.0 ± 14.5 min in the medial approach group ($P = 0.002$). This difference could be attributed to better control of both aspects of fracture site (anterior and posterior) with medial approach and relatively easily insertion of medial K-wire. Although rotation was better controlled with posterior approach as expected, this condition did not affect duration of operation in medial approach cases. Furthermore, triceps cut and repair performed in posterior approach may also contribute to increased duration of operation.

Functional outcome following pediatric supracondylar fractures mainly depend on the amount of soft tissue compromise and failure of reduction and failure of maintenance of reduction.^[18] It is a topic of debate whether type of approach could have an effect on outcome when open reduction is required. Numerous studies reported functional and cosmetic outcome with different approach types. When functional and cosmetic outcome was assessed according to Flynn's criteria; Barlas *et al.* reported 90.69% good-excellent results at 2 years follow-up with medial approach.^[11] Similarly, Ramsey *et al.* reported 95% good-excellent results at 4-year follow-up treated similarly with medial approach.^[19] Eren *et al.* compared lateral and medial approaches.^[20] In their study, good-excellent results were reported 95% functionally and 100% cosmetically with lateral approach; whereas 100% both functionally and cosmetically with medial approach without statistical significance. Likewise, Waikhom *et al.* reported satisfactory cosmetic and functional results, even in delayed cases using medial approach.^[21] Similar to medial approach, good-excellent results were reported to be between 52 and 85.7% functionally and 74-100% cosmetic using posterior approach.^[10,16,17,22,23] In our study good-excellent results achieved functionally and cosmetically respectively were 93.8% and 100% in medial approach cases and 97.1% and 100% in posterior approach cases ($P = 0.34$). Both approaches revealed comparable results without insignificant difference. Cosmetic satisfaction could be attributed to absence of residual deformity and relatively cosmetic location of incisions (posterior and medial).

Open reduction facilitates direct fracture visualization and anatomical reduction, resulting with optimal alignment.^[14,24,25] In the current study, radiological follow-up (Baumann and humero-capitellar angles) measurements revealed similar and acceptable results, as expected.

Regarding complications, medial approach was shown to be advantageous to other approaches on both avoidance of iatrogenic ulnar nerve injury due to direct inspection while pin insertion and avoidance of varus deformity postoperatively similarly direct inspection of medial cortices and reduction.^[26] Barlas *et al.* reported no incidence of ulnar nerve injury using medial approach in 43 cases of pediatric supracondylar fractures.^[11] Weiland *et al.* reported 25% rate of cubitus varus deformity in mid-term follow-up of 52 cases treated with lateral approach open reduction.^[27] Whereas Shiffrin *et al.* did not observe any case of cubitus varus deformity in hundred supracondylar humerus fracture cases treated with medial approach open reduction.^[28] In our study population, we also did not encounter any case of cubitus varus deformity or iatrogenic ulnar nerve injury.

Gruber *et al.* reported that, although a very good field of view is provided by the posterior approach in which the triceps muscle is cut, the damaged muscle prevents early rehabilitation and the scar texture causes limitation of movement, which in turn leads to frequent findings of extension loss.^[29] Although Kassler *et al.*^[30] reported approximately 3% decrease in triceps power following posterior approach, Sibly *et al.*^[31] did not see any significant difference in postoperative ROM between cases treated with closed reduction and open reduction via posterior approach. In the current study, no significant difference was noted between two groups regarding ROM loss.

This retrospective analysis of two different approach types for surgical treatment of pediatric supracondylar humerus fractures revealed that both posterior and medial approach results with predictable outcome and safety. Slight reduction of operative time can be expected using medial approach.

CONCLUSIONS

In the treatment of Gartland type III supracondylar humerus fractures in children, the functional and radiological outcomes of posterior and medial approaches are similar. The operation time is shorter with medial approach.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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