Comparison of Posterior and Combined Medial-lateral Surgical Approaches in the Treatment of Supracondylar Fractures of the Humerus among Children

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Purpose: *The most effective surgical approach for the surgical treatment of supracondylar fractures has not yet been established. Two commonly used approaches are a posterior approach and a combined medial-lateral approach. We performed a retrospective study to compare these two treatment strategies.*
Methods: *A total of 66 patients were selected for review. Each patient was treated by one of the two approach methods. Data including operative time, blood loss, radiological results, the range of motion of the elbow, Flynn's criteria, and operative complications were collected.*
Results: *Thirty-two patients were treated with a posterior approach, and the rest (34) were treated with a combined medial-lateral approach. A posterior approach was associated with a significantly shorter operative time. There were no significant differences in blood loss, radiological results, the range of motion of the elbow, Flynn's criteria, and complications between the two groups.*
Conclusion: *The posterior approach technique was as effective as the combined medial-lateral approach in the treatment of supracondylar fractures, but provided shorter operative times.*

Keywords: *Supracondylar fractures, posterior approach, combined medial-lateral approach*

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Introduction

Supracondylar humeral fractures are common pediatric injuries[1], representing about 3% of all fractures[2] and are the most common elbow fracture[3]. Incidence rates of supracondylar humeral fractures has been reported to be higher in boys compared to girls, while girls tend to show higher rates of supracondylar fractures in some series.According to the modified Gartland classification[4, 5], the majority of supracondylar humeral fractures are extension-type fractures. Severely displaced supracondylar humeral fractures are challenging to treat[6] and entail technically difficult procedures for orthopedic surgeons.

The literature has supported closed reduction and percutaneous pinning as the treatment of choice for these fractures[7]. Although irreducible fractures (mostly due to interposition of the brachialis muscle, median nerve, and brachial artery) are uncommon, 2–12% require open reduction[8]. Surgical exposure can be accomplished by a variety of approaches[9]. An ideal surgical approach should permit safe and rapid reduction, to obtain full anatomic alignment, adequate functional and cosmetic outcomes, as well as having a lower rate of complications. Bamrungthin compared the posterior and lateral approaches with the conclusion that the posterior approach is easier[10]. Lateral approaches afford only a partial view of the fractures. As a result, a lateral incision is often combined with a medial incision to improve the view of the fracture and control the rotation of the fracture. The loss of reduction following fracture fixation is associated with poor surgical technique fixation with lateral pinning only[11].

The purpose of this study was to compare the outcomes of treatment between the two approaches. The functional recovery and operative complications were also examined in detail.

Patients and methods

This retrospective review included patients with supracondylar humeral fractures surgically treated at Sawangdandin Crown Prince hospital between 2007 and 2014. The inclusion criteria were (a) patients with acute and unilateral fracture, (b) displaced fracture (Gartland classification Type III), (c) posterior or combined medial-lateral surgical approaches with K-wire fixation, (d) less than 12 years of age, (e) failure of closed reduction and (f) normal elbow function before injury. The exclusion criteria included (a) pathological fractures, (b) primary or metastatic bone tumors, (c) bilateral fractures, (d) open fractures, (e) ipsilateral limb injuries, and (f) major

neurological deficits.

The type of approach used for surgical treatment of supracondylar humeral fractures was not randomized, they were alternated.

Surgical technique

For the posterior approach group, patients with supracondylar humeral fractures were treated with open reduction and internal fixation (ORIF) with K-wire. Under general anesthesia, closed reduction was attempted for all supracondylar humeral fractures. The presence of inadequate reduction led to open reduction and pinning. The patient was placed in a lateral decubitus position. By a midline posterior skin incision, the triceps muscle was split longitudinally. After exposure of the fracture site, the fragments were reduced and fixed by crossed pinning; two in each column. The ulnar nerve was explored and retracted medially. The muscle and fascia were closed by interrupted sutures with Vicryl. The subcutaneous tissue was also closed with Vicryl and the skin with nylon. A posterior long arm splint was applied with the elbow in 90° flexion and forearm in pronation. (Figs. 1 and 2) After 2 weeks the sutures were removed. The pins were removed in the next two weeks and active elbow motions were begun.

Fig. 1 Anteroposterior and lateral radiographs of a supracondylar humeral fracture of a 5-year-old girl.

Fig. 2 Radiographs taken 2 weeks after surgery

For the combined medial-lateral approach group, under general anesthesia, a closed reduction was attempted for all supracondylar humeral fractures. The presence of inadequate reduction led to open reduction and pinning. The patients were in a supine position. An incision was made from 3-4 cm proximal to 2-3 cm distal to the lateral epicondyle. After dissection between brachioradialis and triceps muscles, the fracture site was exposed, reduction was performed and the fragments were fixed by two K-wires in the lateral column. An incision was then made from 3-4 cm proximal to 2-3cm distal to the medial epicondyle. After achieving reduction as anatomical as possible, two medial K-wires were inserted to stabilize the fracture. The entry point was at the anterior part of the medial epicondyle and engaged the posterior cortex of the proximal fragment. The protruded K-wires were cut long to facilitate subsequent removal without anaesthesia. Wound closure and postoperative care were similar to the first group (Figs. 3 and 4).

Fig. 3 Anteroposterior and lateral radiographs of a supracondylar humeral fracture of a 5-year-old boy.

Fig. 4 Radiographs taken 2 weeks after surgery

Standard anteroposterior and lateral radiographs of the elbow were obtained and evaluated every 4 weeks, for fracture healing, non-union, malunion, loosening of implant, loss of

reduction, Baumann's angle, and shaft condylar angle.

Operative times, blood loss, the range of motion of the elbow, and complications were recorded.

At 6 months follow up, we used Flynn's criteria to assess the functional outcome (loss of motion) and cosmetic outcome (carrying angle)[12].

Statistical analysis

Descriptive statistics were compiled for all data points. Chi-square was used to compare categorical variables. Independent samples Student's *t*-test was used to compare continuous variables between two groups. *P*-values less than 0.05 were considered statistically significant.

Results

There were 66 patients in the present study, with an average age of 6.3 years (range 3 years to 9 years). All were followed up for more than six months after discharge from the hospital. The average follow-up time was 12.6 months (range 6 months to 24 months). The patients were divided into two groups based on the approach of treatment. The posterior approach group included 32 patients and the combined medial-lateral approach group included 34 patients. The mechanisms of injury and demographics data relating to each group are shown in Table 1.

The mean operative time was 36 minutes for the posterior approach group and 54 minutes for the combined medial-lateral approach group; this difference was significant. There were no significant differences in blood loss, radiological result, and the range of motion of the elbow at the follow-up at 6 months. The details of the outcomes are given in Table 2. There were no significantly different functional outcomes, as shown in Table 3. There were no significantly different cosmetic outcomes, as shown in Table 4.

Table 1 The injury mechanism, length of hospital stay, and preoperative demographics for both treatment groups

Characteristics	Posterior approach (n=32)	Combined medial-lateral approach (n=34)	*P*- value
Gender (M/F)	19/13	22/12	0.655
Side (R/L)	10/22	13/21	0.552
Age (years): mean (SD)	6.2 (0.8)	6.4 (0.9)	0.427
Injury time to operation (days) : mean (SD)	1.4 (0.3)	1.5 (0.4)	0.687
Follow-up (months) : mean (SD)	12.5 (3.1)	12.7 (3.2)	0.717
Length of hospital stay (days) : mean (SD)	3.3 (0.4)	3.5 (0.5)	0.673

Table 2 Comparison of outcomes between the two treatment groups

Outcome	Posterior approach (n=32)	SD	Combined medial-lateral approach (n=34)	SD	*P-value*
Operative time (min)	36 (range, 31-42)	3	54 (range, 41-68)	6	<0.01
Blood loss (ml)	108 (range,50-150 ml)	24	111 (range, 50-150 ml)	26	0.484
Baumann's angle difference from normal side (degree)	3.9 (range, 1-7)	0.8	4.1 (range, 1-7)	0.9	0.695
Shaft condylar angle difference from normal side (degree)	1.8 (range, 1-3)	0.4	1.9 (range, 1-3)	0.5	0.544
Elbow flexion (degree)	134 (range, 90-145)	6	132 (range, 90-144)	5	0.582
Extension lag (degree)	4.8 (range, 1-10)	1.0	5.1 (range, 1-10)	1.2	0.483

Table 3 Functional outcomes according to surgical approach

	Posterior approach (n=32)	Combined medial-lateral approach (n=34)
Excellent	17 (53.1%)	19 (55.8%)
Good	8 (25%)	10 (29.4%)
Fair	5 (15.6%)	4 (11.7%)
Poor	2 (6.2%)	1 (2.9%)

Table 4 Cosmetic outcomes according to surgical approach

	Posterior approach (n=32)	Combined medial-lateral approach (n=34)
Excellent	18 (56.2%)	20 (58.8%)
Good	9 (28.1%)	10 (29.4%)
Fair	3 (9.3%)	3 (8.8%)
Poor	2 (6.2%)	1 (2.9%)

Postoperative complications noted in both groups were not significantly different (P = 0.660). There were 7 cases of superficial infections diagnosed clinically at the first follow-up visit seven days after surgery. After seven days of treatment with oral antibiotics, the wound healed uneventfully. One patient developed neurapraxia of the ulnar nerve. He recovered in 6 weeks (Table 5).

Table 5 Comparison of complications in both groups

	Posterior approach (n=32)	Combined medial-lateral approach (n=34)
Infection	3	4
Ulnar nerve injury	1	0
Malunion	1	0
Stiffness	1	1
Total	6	5

Discussion

The treatment of choice in displaced supracondylar humeral fractures is closed reduction and percutaneous pinning[13]. The most common causes for a failed reduction are muscle, joint capsule, and periosteum interpositions[14-15]. Our study found brachialis muscle interposed. Open reduction is indicated in cases of failure of closed reduction, vascular or neural injury, open fractures, and severe swelling[16].

Surgical exposure has been reported by a variety of approaches. A good surgical approach should be simple, has a shorter operative time, causes less damage to organs, has a low risk of stiffness, and results in normal functionality and cosmetic appearance of the elbow [17]. The posterior approach had no high risk of stiffness compared with the other type of surgical approach[18]. Our study shows the posterior approach provided shorter operative times than the combined medial-lateral approach, and had one incision which gave the surgeon a good view and a perfect reduction can be obtained.

Previous study showed a low frequency in fair or poor cosmetic outcomes, internal rotation of the distal fragment, and medial side comminution is the cause of loss of carrying angle[19].

There were a few complications in both groups. There was an ulnar nerve injury in the posterior approach group. This could be because the ulnar nerve was not under direct vision when applying the crossed K-wires. There were a few pin tract infections in both groups, which present in up to 8% of cases[20], and could be resolved by oral antibiotics and removing the pins.

Our study had a few limitations: namely, (a) it was a retrospective study and was not randomized, so there could be selection bias (b) the size of the study was small, for power of the test >80%, we should have had 60 patients in each group.

Conclusion

Both posterior and combined medial-lateral approaches for the treatment of supra-condylar humeral fractures tend to achieve comparable good results. However, the posterior approach had more advantages in shorter operative times than the combined medial-lateral approach.

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การศึกษาเปรียบเทียบระหว่าง การผ่าตัดเข้าด้านหลัง และ การผ่าตัดเข้าด้านนอกและด้านใน ในการรักษาผู้ป่วยที่มีกระดูกต้นแขนบริเวณข้อศอกหักในเด็ก

สมบูรณ์ วุฒิพิริยะอังกูร, พบ

วัตถุประสงค์: *เพื่อศึกษาเปรียบเทียบผลการรักษาระหว่างการผ่าตัดเข้าด้านหลัง และ การผ่าตัดเข้าด้านนอกและด้านในในการรักษาผู้ป่วยที่มีกระดูกต้นแขนบริเวณข้อศอกหักในเด็ก*

วิธีการศึกษา: *การศึกษาวิจัยแบบย้อนหลังโดยดูระยะเวลาในการผ่าตัด, การเสียเลือด, Baumann's angle, Flynn's criteria, และผลแทรกซ้อน*

ผลการศึกษา: *ผู้ป่วย 66 ราย แบ่งเป็น 2 กลุ่ม การผ่าตัดเข้าด้านหลัง 32 ราย และ การผ่าตัดเข้าด้านนอกและด้านใน 34 ราย ผลการรักษาพบว่าไม่ความแตกต่างกันในเรื่องของการเสียเลือด, Baumann's angle, Flynn's criteria และผลแทรกซ้อน แต่กลุ่มการผ่าตัดเข้าด้านหลัง ใช้ระยะเวลาในการผ่าตัดน้อยกว่าอย่างมีนัยสำคัญ (P< 0.05)*

สรุป: *การผ่าตัดเข้าด้านหลังมีคุณภาพเท่ากับการผ่าตัดเข้าด้านนอกและด้านใน ในการรักษาผู้ป่วยที่มีกระดูกต้นแขนบริเวณข้อศอกหักในเด็ก โดยใช้ระยะเวลาในการผ่าตัดน้อยกว่า*