ORIGINAL ARTICLE

Middle and long term radiologic and functional results of childhood supracondylar humeral fractures operated in first 24 hours with limited medial approach

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Abstract

Objective: To investigate the middle- and long-term radiological and functional results of children with type III supracondylar humerus fractures treated with a limited medial approach and internal fixation.

Methods: The retrospective study was conducted at Department of Orthopaedics in Goztepe Training and Research Hospital, Istanbul, Turkey, and comprised data of children who underwent surgery between April 1991 and June 2009. Patients in group I underwent surgery within the first 8 hours after admission, and those in group II did so 8-24 hours after admission. Patients were evaluated according to the Flynn scoring system.

Results: Of the 79 patients, 52(65.8%) were male and 27(34.2%) were female. Fractures involved the left side in 49(62%) patients. Group I had 39(49.4%) patients and group II 40(50.6%). The overall mean age was 6.2±2.95 years (range: 2-13 years), and the mean follow-up was 53.2±14.9 months (range: 26-193 months). Functional scores were satisfactory (excellent, good and fair results) in all cases in both groups (100%), and the cosmetic results were satisfactory in 37(95%) in group I, and 39(97.5%) in group II ($p>0.05$).

Conclusion: Limited medial approach to the treatment of supracondylar humerus fractures yielded successful functional and cosmetic results.

Keywords: Medial approach, Paediatric fractures, Supracondylar humeral fractures. (JPMA 66: 393; 2016)

Introduction

Supracondylar humerus fractures account for 60-75% of all fractures of the elbow in children.[1] Boys usually have a higher incidence of this type of fracture, but some recent reports in literature have described increasing rates in girls. Most patients are 5-7 years of age.[2] The fracture typically occurs due to a fall on to an outstretched hand with hyperextension of the elbow joint.[3] The distal fragment displaces posteriorly in more than 95% fractures.[2,3] Various methods have been described for treating paediatric supracondylar humerus fractures.[1,2] It has been reported that conservative treatment is mainly preferred for undisplaced fractures, whereas closed reduction and percutaneous pinning are chosen for displaced fractures.[3] Open reduction may be considered when an acceptable reduction cannot be achieved via the closed technique, a fluoroscopy device is not available, or the surgeon has insufficient experience in close reduction and percutaneous pinning.[4] Approaches from four different anatomical regions to the elbow region have been discussed in the literature. However, there has been no adequate study of these approaches to indicate the superiority of one over another.[5]

In our study, if we were unable to apply closed reduction, and instead performed open reduction in a number of cases, regardless of whether the fracture occured under flexion or extension. To avoid damaging the vessel and nerve systems, we considered the limited medial approach to be the safest and best method. Using this method, fractures carrying a high risk of serious vascular complication can be safely managed. Removing the fracture haematoma and maintaining reduction relieves the circulation. If necessary, such an incision makes it possible to visualise and explore the neurovascular structure.

The current study was planned to investigate the mid- and long-term results of open reduction using a limited medial approach and internal fixation in paediatric extension and flexion type III supracondylar humerus fractures.

Materials and Methods

The retrospective study was conducted at Department of Orthopaedics in Goztepe Training and Research Hospital, Istanbul, Turkey, and comprised data of children who underwent paediatric supracondylar humerus fracture

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surgery between April 1991 and June 2009. Cases managed with closed reduction and percutaneous pinning and those in whom open reduction was performed through surgical approaches other than the medial were excluded.

Surgery was performed on all patients by a single surgeon in cases where closed reduction could not be completed or vessel-nerve damage was present. Consequently, open surgery with a limited medial approach followed by flouroscopy-controlled pinning was preferred. All patients underwent surgery within 24 hours of trauma. Patients in group I underwent surgery within the first 8 hours after admission, and those in group II did so 8-24 hours after admission. The Flynn criteria were used to compare the cosmetic and functional results of both groups.[6]

All patients were treated under general anaesthesia by medial minimal open reduction and internal fixation (ORIF) after the failure of closed anatomical reduction. Tourniquet use was not required. The skin incision was initiated 3cm proximal to the elbow joint line and extended posteromedially to the distal part of the medial epicondyle. With this approach, the dermis subdermis was dissected until the ulnar nerve and fracture line were exposed through the medial intermuscular aperture. After removal of the fracture haematoma, an indirect reduction was obtained via this aperture by using an index finger (Figure-1). K-wires 1-1.5mm diameter were inserted under flouroscopy from both condyles with a 45° angle to the humerus shaft for fixation. After stability and circulation had been controlled, the tissue layers were closed by atraumatic sutures. The elbow was fixed using a long arm splint at 90-100° of flexion. Following the operation, radiological control imaging was performed (Figure-2A-D). By the third week post-surgery, the splint was removed and active exercises were started. After the pins were removed at the fourth week, the patient and patient's relatives were provided with information regarding the rehabilitation programme. All patients were followed up at 3-month intervals in the first year and at 6-month intervals in the second year, after which routine follow-up of cases came to an end.

In the final visits, physical and neurological surveys and radiological control imaging (Figure-2 E-F) of both upper extremities were performed. Bilateral elbow movements were measured using a goniometre. Carrying angles were measured with the McRae method on both sides. The Baumann angle was considered to be the best indicator of a displacement of the distal humerus. This angle decreased in the medial tilt of the distal fragment and increased the lateral tilt. The correlation with the carrying angle was significant, and every 5º of difference at the Baumann angle created 2º of change at the carrying angle.[7] Data was assessed on Flynn criteria.

SPSS 11 was used for statistical analysis. Parametric comparisons were based on means, standard deviations, frequencies and percentages. Student's-t test and chi-square test were used and results were found to have a confidence interval (CI) of 95% with a significance value of $p<0.05$.

Results

Data of 576 patients diagnosed with Gartland type III fractures was identified. Among them, limited medial approach was used in 112(19.4%) cases, and complete medical record, including the final follow-up, was available for 79(70%) of them. Of the 79 cases, 52 (65.8%) were male and 27 (34.2%) were female. The mean age was 6.2± 2.95 years (range: 2-13) years. The left side was involved in 49 (62.0%) patients and the right side in 30 (38.0%). Of the total, 39(49.4%) patients in group I underwent surgery in the first 8 hours of admission, and 40(50.6%) in group II 8-24 hours. The mean follow-up was 53.2 ± 14.9 months (range: 26-193). The cause of injury in 42 (53.2%) patients was fall to the ground, 32 (40.5%) fell from a height, and 5 (6.3%) fell off a bicycle. In terms of season, 32 (40.5%) patients suffered injury during the summer, 17 (21.5%) in the spring, 16 (20.3%) in the winter, and 14 (17.7%) were in the autumn.

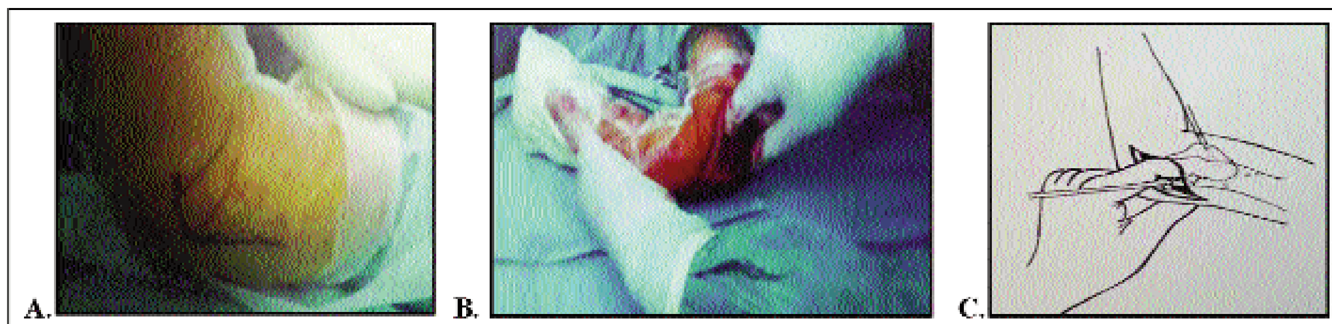

Figure-1: A) Incision line at the elbow. B-C) Indirect reduction of the fracture using a finger.

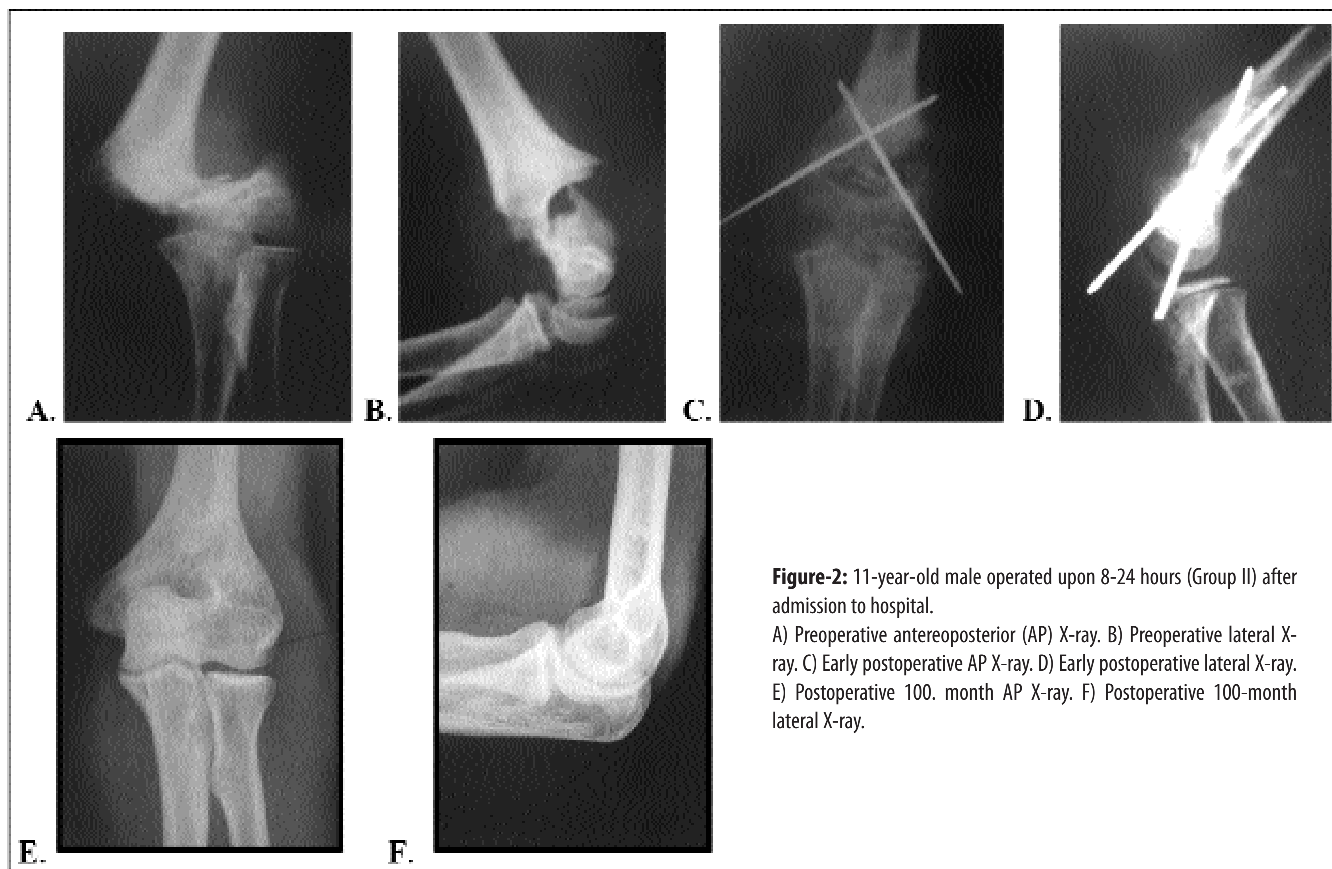

Figure-2: 11-year-old male operated upon 8-24 hours (Group II) after admission to hospital.
A) Preoperative antereoposterior (AP) X-ray. B) Preoperative lateral X-ray. C) Early postoperative AP X-ray. D) Early postoperative lateral X-ray. E) Postoperative 100. month AP X-ray. F) Postoperative 100-month lateral X-ray.

Radial nerve palsy was diagnosed in 8(10.1%) cases, median and isolated anterior interosseous nerve palsy was in 5(6.3%) cases, and ulnar nerve palsy in 1(1.2%) case. Two (2.4%) patients suffered from pulselessnes of the radial artery and distal circulatory system complications. All neurovascular complications healed without additional treatment during the first 3 months.

According to last follow-up, Flynn's Scoring Criteria the functional scores in all patients in both groups (100%) were satisfactory (excellent, good and fair results), while cosmetic results were satisfactory in 37(95%) in group I, and 39(97.5%) in group II ($p>0.05$). Overall functional results were 100% satisfactory, while cosmetic results were satisfactory in 76(96.2%) patients (Table).

The mean carrying angle of the normal elbow was 10.08±3.21° and that of the fractured arm was 7.66±5.63° ($p=0.186$). In females, the corresponding values were 10.93±3.56° and 8.26±5.71°, while in n males they were

Table: Flynn criteria according to operation time.

Flynn Outcome Criteria		Operation Time					
		0-8 Hour		8-24 Hour			
		n	%	n	%	Chi-square Test	p
Cosmetic	Excellent	34	87.2	35	87.5		
	Good	3	7.7	4	10.0		
	Fair	0	0.0	0	0.0	0.47	0.787
	Poor	2	5.1	1	2.5		
Functional	Excellent	35	89.8	34	85.0		
	Good	2	5.1	6	15.0		
	Fair	2	5.1	0	0.0	8.11	0.623
	Poor	0	0.0	0	0.0		

9.63±2.94° and 7.35±5.62° (p=0.498 for the fractured arm; and p=0.090 for the normal arm). Baumann angles of both elbows were compared, and there was an average change in angle for the normal elbow of 75.32 ± 4.59° and an average change in angle for the fractured elbow of 79.04 ± 6.84° (p=0.409).

Cubitus varus deformity developed in 5(6.3%) cases. No iatrogenic ulnar nerve damage was found in any patient. During followups, no complications, such as myositis ossificans, compartment syndrome, fracture non-union or infection, were observed. No patient required a second operation due to a reduction loss or any other reason.

Discussion

There are several studies on paediatric supracondylar humerus fractures. In the case series of Flynn, 84% paediatric supracondylar humerus fractures were seen in children under the age 10.[6] The mean age of occurence was reported as 6.0 years by Khoshbin, 6.3 years by Cheng, and 6.2 years by Nikolic.[8-10] The mean age of our patient group was 6.2 years. In addition, paediatric supracondylar humerus fractures are more common among boys and occur most frequently on the left side.[11] Wilkins reported rates of 62% in boys, 38% in girls, 60.8% on the left side, and 39.2% on the right side.[8] Cheng reported a rate of 1:1.5 on the dominant side.[9] This rate was explained by the fact that the reflex protective mechanism of the patient uses the non-dominant left side during falling.[12] In our study, 52 (65.8%) patients were male, and 27 (34.2%) were female; the fracture occurred on the left side in 49 (62.0%) and on the right side in 30 (38.0%). These results are in accordance with the literature.

According to studies,[6,13-15] paediatric supracondylar humerus fractures are more often seen during the spring and the summer. This prevalence can be explained by the start of the school holidays and the greater amount of time spent outdoors in increasingly ambient temperatures as well as by boys' preference for more boisterous games. Most of our patients visited the emergency room during the summer time. From an aetioligical perspective, Farnswort reported that falling from high places accounted for 70% of supracondylar fractures. Falling from a bed was also common among children of approximately 3 years of age, whereas falls in play areas were common among children of around 4 years of age and older.[14] Of our patients, 42 (53.2%) experienced a fall to the floor, 32 (40.5%) fell from a height, and 5 (6.3%) fell from a bed.

There have been conflicting reports in the literature on the neurological and vascular damage that can develop after such fractures. Dormans found the rate of peripheral nerve injury to be 9.5% in 200 children.[16] This rate has also been presented as 10-15% in various texts.[12] In our study, 8(10.1%) patients had a radial nerve lesion, 5(6.3%) had median and isolated anterior interosseous nerve lesions, and 1(1.2%) had an ulnar nerve lesion. The complaints of all patients were resolved during follow-up. Only 2(2.5%) patients had circulatory problems and radial pulselessness. Following ORIF, the pulse and circulation recovered.

Promising results have recently been reported for the treatment of these fractures by closed reduction and percutaneous fixation.[6,17] The advantages of this method include short hospitalisation, minimal surgery, and lower rates of infection and myositis ossificans. On the other hand, the disadvantages include the risk of ulnar nerve injury during K-wire insertion and the increased use of flouroscopy and X-ray exposure. In addition, repeated manoeuvers during closed reduction may lead to neurovascular injury.[18,19] Indeed, open reduction has been a recommended form of treatment for this fracture from the beginning. However, open reduction has also been considered for open fracture cases in situations with neurovascular injury, in the absence of a fluoroscopy device, or when the surgeon has insufficient experience in percutaneous detection.[8,20,21] Anterior, lateral, medial, and posterior approaches are preferred when open reduction is necessary. However, a common surgical approach has not yet been determined. The advantages and disadvantages of all surgical approaches have been presented in the literature, and satisfactory results have been achieved with all. It is well known that such favourable results are in direct correlation to the surgeon's experience. Surgeons usually prefer the approach with which they have the most experience. The aim of surgical treatment is to gain the best functional results with minimal cosmetic problems.

With this in mind, we performed a modified version of the medial approach recommended by Danielson-Peterson in all patients.[21] The surrounding tissues were protected by minimal dissection and surgical trauma. Sufficient anatomical reduction of the medial and lateral columns was possible by palpation and under direct vision when necessary. In addition, we observed that rotations in the coronal, saggital, and axial planes could be retracted during open reduction. We achieved maximal stabilisation by medial and lateral cross-pins following localisation of the ulnar nerve. The current literature also recommends cross-pins for maximal stabilisation.[22] As the incision is medial, it allows the ulnar nerve to be located and prevents iatrogenic ulnar nerve injury. We found that

this approach yielded very good cosmetic results in all patients except 3(3.79%), and all patients were satisfied with the results.

To evaluate a surgical approach favourably, we must determine that the long-term results are as satisfactory as the short-term results. Our evaluation of the long-term outcomes of our patients based on Flynn's criteria revealed 97.5% excellent, good, and fair results according to the functional assessment and 96.2% excellent, good, and fair results according to the cosmetic assessment.

Some authors have suggested that a carrying-angle loss greater than 10° is not acceptable and that the ideal difference should be less than 5°,[6,8] because the most important late complication after paediatric supracondylar humerus fractures is the development of cubitus varus or cubitus valgus deformity. Varus deformity is more apparent cosmetically and is the source of more patient complaints than cubitus valgus deformity.[12,23,24] We observed cubitus varus deformity in 5(6.3%) patients, which is in accordance with the literature. During follow-up, 2 of the 5 patients showed a varus deformity less than 10°, and the remaining 3 patients showed a varus deformity greater than 10°. All of these patients complained of curvature, but none had functional complaints.

Finally, according to radiological examinations performed during follow-up visits, none of the patients showed neurovascular complications or myositis ossificans during the postoperative period. It has been reported that repeated and forcing manoeuvers during closed reduction in patients who are treated with repetitive manipulations may lead to myositis ossificans.[25] We suggest that our approach may reduce the risk of myositis ossificans.

The limitations of our study are its retrospective design, small sample size, and absence of randomisation, with the surgical strategy being dependent on the usual practice of a single centre.

In light of these results, we suggest that our treatment approach is a safe and convenient method to restoring the humerus supracondylar region anatomy, because ORIF can be performed by the medial approach without risk of injury to the surrounding tissues of the elbow. In addition, this method proves advantageous post-operationally.

Conclusion

Limited medial approach to paediatric supracondylar humerus fractures is a safe and successful method in terms of the functional and cosmetic results. The approach may be preferred in patients with type 3 paediatric supracondylar humerus fractures in whom closed reduction may have failed to provide sufficient anatomical reduction.

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