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Surgical Outcome of Pediatric Medial Humeral Epicondylar Fracture with a Displacement of More Than 2 Millimeters

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Abstract

Background: Recent evidence supports the superiority of surgery over conservative treatment in the management of medial humeral epicondylar fractures (MHEF) with the displacement of more than 2 mm, regardless of other indications for surgical intervention.

Objectives: We evaluate this strategy in a cohort of pediatric MHEF with more than 2 mm displacement.

Methods: A total of 10 pediatric patients with MHEF and more than 2 mm displacement were included in the study. Relative and absolute indications for surgical intervention were present in five and one patient, respectively. No surgical indication was present in the other four cases. Elbow dislocation had occurred in three cases. All the patients were treated with open reduction and internal fixation (ORIF). The outcome measures included: Radiographic union, elbow range of motion, and Mayo elbow performance score (MEPS).

Results: At the final follow-up session, the mean flexion was 129° ± 6.1°. Flexion contracture and hyperextension were seen in three (30%) and one (10%) patient, respectively. The mean supination and pronation were 81° ± 3.2° and 80.5° ± 1.6°, respectively. MEPS was 100 (excellent) in nine patients and 55 (poor) in one patient. Radiographic union was observed in all the patients. In one patient, ulnar nerve neurolysis was performed 23 months after the initial surgery due to severe tenderness around the medial epicondyle.

Conclusions: ORIF management of MHEF is an easy procedure with a low complication rate and satisfactory outcomes. Thus, we suggest the surgical approach for all pediatric patients with MHEF and displacement of > 2 mm, regardless of the presence of other indications for surgery.

Keywords: Medial Humeral Epicondylar Fractures, Open Reduction and Internal Fixation, Pediatric Patients

1. Background

Medial humeral epicondylar fracture (MHEF) accounts for nearly 12% of all elbow fractures in the pediatric population (1). Elbow dislocation, medial epicondyle fragment incarceration within the elbow joint, and ulnar nerve dysfunction have been reported in 50%, 15% - 18%, and 10% - 16% of MHEF cases, respectively (1, 2).

Open fractures and intra-articular incarceration of fractured fragments are absolute indications for surgical management of MHEF. Ulnar nerve entrapment, gross elbow instability, and early return to high-demand activities are considered as the relative indications for surgery (3). Recently, a growing consensus supports the notion that MHEF with a displacement of greater than 2 mm could also benefit open reduction and internal fixation (ORIF) (4-6). Yet, there is an ongoing debate regarding the management of MHEF cases that do not meet the distinct surgical indications, and a detailed rationale for choosing surgical versus non-surgical management is lacking, specifically in the pediatric population (3, 7, 8).

Although the non-surgical management of MHEF could result in a good or excellent functional outcome, even if healed with fibrous union (9), a complication rate of as high as 53% has been reported following the nonoperative management, with 47% of those patients needing surgery within three years (10). Moreover, the odds of union following the operative treatment is calculated to be 9.33 times the odds of union with nonoperative treatment, and nonunion rate of as high as 90% has been reported following the nonoperative treatment (8). Accordingly, several questions regarding the management of pediatric MHEF remain unanswered.

2. Objectives

We report the results of surgical treatment in a cohort of pediatric MHEF patients with the displacement of more than 2 mm regardless of their indications for surgery.

3. Methods

This study was approved by the review board of our institute and informed consent was obtained from the patients' parents to use their medical data for publication. In a retrospective study, patients who had referred to our center from 2015 to 2017 and met the eligibility criteria of the study were included. The inclusion criteria were age less than 16 years and displacement of > 2 mm. Patients with the follow-up of less than three months, multiple trauma, and multiple fractures were excluded from the study. Patients who were not available for final assessments were also excluded.

Union was assessed using plain anteroposterior and lateral radiographs. Elbow range of motion was assessed by a goniometer and two fellowship-training orthopedic surgeons who evaluated the patients separately. The performance of the elbow was assessed using the Mayo elbow performance score (MEPS) (11), with a range of 0-100 points. Accordingly, a score of 90 to 100 points was classified as an excellent functional outcome, while scores of 75 to 89, 60 to 74, and < 60 points were regarded as good, fair, and poor functional outcomes, respectively.

3.1. Surgical Technique

Surgery was performed as described in Kamath et al. study (12). Briefly, after appropriate anesthesia, the patient was placed in the supine position on the operating table, while the entire operative extremity was extended onto a hand table. Under the tourniquet application, a medial incision of nearly 8 cm was made over the patient's elbow, just posterior to the epicondyle. The ulnar nerve was explored and protected. The medial epicondylar fragment was anatomically reduced and fixed using pins or cannulated screws, based on the size of the fracture. After fixation of the fracture, anterior subcutaneous transposition of the ulnar nerve was performed.

3.2. Postoperative Protocol

Postoperatively, the elbow was immobilized in a long arm splint at 90° flexion and neutral pronation/supination of the forearm for two weeks. In circumstances with pin fixation, the pins were removed six weeks after the surgery, provided radiologic union was obtained.

4. Results

A total of 10 eligible pediatric patients with MHEF and a displacement of > 2 mm who underwent surgical treatment were included in this study. Relative and absolute surgical indications were present in five and one patient, respectively, while no surgical indication was present in the other four patients. Elbow dislocation was seen in three cases. The mean age of the patients was 13.4 ± 2.1 years, ranging from 10 to 16 years. The study population included 9 (90%) males and 1 (10%) female. The injury was dominant in 4 (40%) patients and non-dominant in 6 (60%) patients. The mechanism of injury was motor vehicle accident in 5 (50%) cases, falling in 3 (30%) cases, and contact sport in 2 (20%) cases. The mean follow-up period of the patients was 9.7 ± 9.5 months, ranging from 3 to 34 months. The mean time from injury to surgery was 5.7 ± 4.7 days. The fracture was fixed with two 1.5-mm pins in five cases, three 1.5-mm pins in one case, and one 4.5-mm cannulated screw in four cases (Figure 1). The clinical, demographic, and surgical characteristics of the patients are demonstrated in detail in Table 1.

The mean flexion of the final follow-up session was 129° ± 6.1°, ranging from 120° to 140°. Full extension was observed in six patients. Three patients ended up with some degrees of flexion contracture (cases 3, 8, and 10). Hyperextension of 10° was seen in case 9. The mean supination was 81° ± 3.2°, ranging from 80° to 90°. The mean pronation was 80.5° ± 1.6°, ranging from 80° to 85°. The mean MEPS was 86.5 ± 30.4, ranging from 55 to 100. MEPS was 100 (excellent) in nine patients and 55 (poor) in one patient. The outcome measures of the patients are illustrated in detail in Table 2.

4.1. Post-Operative Complications

Radiographic union was observed in all the patients at the last follow-up session. Post-operative instability was not observed in any of the patients. A mild ulnar nerve neuropathy was noted in case number 1 both before and after the surgery, diagnosed as cubital tunnel syndrome. No surgical intervention was considered to remedy this matter. Severe medial epicondyle pain was seen in on patient after the surgery (case number 5) and led to a significant reduction in the MEPS score. We suspected ulnar nerve neuroma and the patient underwent ulnar nerve exploration, microdissection, and ulnar nerve neurolysis 23 months after the initial surgery. No complaint was reported by the patient afterwards.

5. Discussion

Although the outcome of surgery is generally satisfactory in pediatric MHEF, a variety of post-operative com-

Table 1. The Clinicodemographic and Surgical Characteristics of the Pediatric Patients with Medial Humeral Epicondylar Fractures and a Displacement of > 2 mm

ID	Age, y	Gender	Injured Hand Dominancy	Mechanism of Injury	Follow-Up, mo	Delay in Surgery, d	Indication For Surgery	Elbow Dislocation	Fixation Material
1	15	Male	Dominant	MVA	16	0	Ulnar neuropathy	Positive	Two 1.5 mm pins
2	16	Male	Non-dominant	Contact sport	8	2	High-demand activity	Negative	One 4.5 mm cannulated screw
3	14	Male	Non-dominant	Falling	5	10	None	Positive	Two 1.5 mm pins
4	12	Male	Non-dominant	Falling	12	10	None	Negative	Two 1.5 mm pins
5	11	Female	Non-dominant	MVA	34	14	Ulnar neuropathy	Negative	Two 1.5 mm pins
6	13	Male	Dominant	MVA	4	3	Ulnar neuropathy	Negative	Three 1.5 mm pins
7	12	Male	Non-dominant	Falling	3.5	9	None	Negative	One 4.5 mm cannulated screw
8	16	Male	Dominant	Contact sport	3	5	High-demand activity	Negative	One 4.5 mm cannulated screw
9	15	Male	Dominant	MVA	8	3	None	Negative	One 4.5 mm cannulated screw
10	10	Male	Non-dominant	MVA	3.5	1	Intra-articular incarceration	Positive	Two 1.5 mm pins

Abbreviation: MVA, motor vehicle accident.

Table 2. The Outcome Measures Following the Surgical Management of Pediatric Medial Humeral Epicondylar Fracture with a Displacement of > 2 mm

ID	Flexion, °	Flexion Contracture, °	Supination, °	Pronation, °	MEPS	Functional Outcome
1	125	0	80	80	100	Excellent
2	130	0	80	80	100	Excellent
3	120	10	80	85	100	Excellent
4	130	0	80	80	100	Excellent
5	140	0	90	80	55	Poor
6	130	0	80	80	100	Excellent
7	130	0	80	80	100	Excellent
8	120	20	80	80	100	Excellent
9	135	-10 (hyperextension)	80	80	100	Excellent
10	130	30	80	80	100	Excellent

Abbreviation: MEPS, Mayo elbow performance score.

plications such as elbow stiffness, ulnar nerve symptoms, hypoplasia, and pseudarthrosis have been reported (6, 13). For this reason, surgical management is historically avoided whenever possible (14). Yet, non-surgical management also has its own complications including nonunion, valgus instability, and certain functional limitations (8). Accordingly, the debate regarding the choice of treatment in pediatric MHEF continues.

In this study, we assessed the outcome of surgical management in all cases of pediatric MHEF with a displacement of > 2 mm, regardless of their indications for surgery. The mean MEPS score of the patients was 86.5 points (100 in nine patients and 55 in one patient). The mean flexion, pronation and supination were 129°, 80.5°, and 81°, respectively. Ulnar nerve complaint was the main complication in our study that was seen in two patients. No case of nonunion was observed in our series.

Kamath et al. in 2009 systematically reviewed the outcome of operative versus non-operative management of pediatric MHEF. Fourteen studies, including 498 patients, met the inclusion/exclusion criteria of their study. Based on their analysis, while the rate of postoperative pain and ulnar nerve symptoms was similar between operative and non-operative management, the odds of nonunion was 9.33 more with nonoperative management (8). Our study also revealed a low rate of non-union following the surgical management of MHEF.

Bede et al. reviewed the results of 50 pediatric MHEF, of which 16 were treated surgically and 34 were treated conservatively. Based on their results, 10 (62.5%) patients in the surgery group and 27 (79.4%) patients in the conservative group had good results (15). Skak et al. also evaluated the outcome of MHEF in a cohort of 24 pediatric patients. Good or excellent results were obtained in 18 out of 21 cases (85.7%) of their series who underwent surgical management and two out of three cases (66.6%) of their series who were treated conservatively (13). Ip and Tsang evaluated the Mayo score in 24 MHEF patients who underwent

Figure 1. Preoperative (A) and post-operative (B) anteroposterior radiographs of a medial humeral epicondylar fracture fixed with one 4.5-mm cannulated screw (case 9); preoperative (C) and post-operative (D) anteroposterior radiographs of a medial humeral epicondylar fracture fixed with two 1.5-mm pins (case 10)

surgery and four MHEF patients who were treated non-surgically. The average Mayo score was 96.25 for conservative and 93 for the surgical group (7). The performance of elbow was excellent in 9 (90%) patients of their series and poor in only one patient (10%).

Wilson et al. assessed the range of motion in 43 pedi-

atric MHEF from which 23 cases were treated operatively and 20 cases were treated non-operatively. Their evaluations revealed a loss of extension of > 10° in 2 (8.7%) patients of the operative group and 6 (30%) patients of the non-operative group (16). Farsetti et al. reported the range of motion in 42 pediatric MHEF patients. MHEF was treated non-operatively in 19 cases, with ORIF in 17 cases and with epicondylar fragment excision in six cases. Based on their results, 2 (10.5%) patients in the non-operative group and 3 (13%) patients in the operative group had extension limitation (14). Ip and Tsang reported no loss of motion in either surgically or non-surgically treated patients (7). A loss of extension of > 10° was seen in 3 (30%) of our patients.

Altogether, it could be concluded that operative and non-operative management of pediatric MHEF both provide acceptable elbow performance and range of motion; however, the rate of post-operative complications, specifically non-union, is higher with conservative management. Recent advances in the surgical management of MHEF have made the outcome of the surgery even more favorable (12). Considering the surgical management of MHEF as a non-complex surgery with a low complication rate, we suggest operative management for all pediatric MHEF cases with a displacement of > 2 mm, regardless of the presence of other indications for surgery.

Our study has some limitations that should be pointed out. The main limitations of this study were the small number of patients and the lack of a control group treated conservatively. Moreover, the follow-up period of the patients was relatively short. Thus, future long-term comparative studies with larger sample sizes are needed to confirm our results.

Footnotes

Conflict of Interests: The authors of this article have no conflict of interest to disclose.

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