Operative fixation of medial epicondyle fractures: complication rates based on mode of fixation

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Abstract

The purpose of this study is to define the rate of implant failure and risk factors for failure in patients treated operatively for displaced medial epicondyle fractures.

Patients <18 years of age with medial epicondyle humerus fractures that were treated with screw or k-wire fixation between 2005 and 2015 were eligible. Inclusion criteria included follow-up until radiographic union and no known medical conditions that could impair healing.

Thirty-four patients with 35 fractures were identified with an average age of 12 years old. 11.4% (n = 9/35) were treated using a screw and washer construction, and 62.9% (n = 22/35) were treated using screw alone. There were 16 reported complications (46%) including implant prominence requiring reoperation (6), implant failure (1), and fracture displacement (1). Other complications included non-union/delayed union (4), new ulnar nerve palsy (2), and decreased range of motion (2). Rates of complications were not different between the types of fixation (P = 1.0). Those who developed complications were younger than those who did not (P = 0.05). 91.4% of patients returned to full activity including weight bearing and throwing sports.

Although 25% of patients experienced implant complications and the overall complication rate approached 50%, nearly all reported return to full activity.

Abbreviations: BMI = body mass index, ROM = range of motion, SD = standard deviation.

Keywords: complication, fixation, medial epicondyle fracture, sports

1. Introduction

Medial epicondyle fractures comprise approximately 12% to 20% of pediatric elbow injuries.[1–5] While the majority of these fractures can be treated nonoperatively, surgery may be performed in cases where the fracture has significant displacement in active children or involves joint instability. Surgical management typically consists of open or percutaneous placement of a single unicortical, intramedullary screw with or without a washer. In some cases, K-wire fixation may be used if the medial epicondyle fragment is too small to accommodate screw diameter due either to the fracture pattern or the size of the ossified piece in younger children. Relatively few complications have been reported though most studies consist of small series.[5–10]

The purpose of this study is to use a large case series of pediatric medial epicondyle fractures over 10 years at a single institution to define any difference in the complication rates based on mode of fixation and to identify risk factors associated with complications. This provides useful information for the provider counseling parents and patients during the preoperative consent process.

2. Methods

An institutional review board approved retrospective review of patients less than 18 years of age diagnosed with medial epicondyle humerus fractures between 2005 to 2015 was conducted at an urban tertiary care institution. Patients were identified using CPT codes for surgical fixation of medial epicondyle humerus fractures. Exclusion criteria included patients lost to follow-up prior to clinical/radiographic healing (n = 16) and any medical condition that could impair bone integrity or fracture healing (n = 0). Data was collected from the
initial preoperative assessment until the patient was clinically and radiographically healed and released to full activity.

Patient charts and radiographs were reviewed. Covariates included sex, age, and body mass index (BMI). Preoperative data including fracture displacement, mechanism of injury, and time from injury to surgery were recorded. The amount of displacement was measured on anteroposterior radiographs as the distance between the most medial, distal edge of the humeral fracture, and the distal portion of the medial epicondyle fragment. If the fracture fragment was incarcerated, the displacement was not measured ($n=9$).

Postoperative data included time to radiographic union, time to return to full activity, and complications. Time of radiographic union was determined by the treating attending surgeon. Time of return to play was defined as when the patient actually resumed full activity as reported by the patient. If the patient reported that they were active but still felt limited by their injured elbow, this was not considered “return to full activity.” Implant complications were defined as displacement of the fixation, implant breakage, and prominence requiring reoperation. Other complications included nonunion or delayed union, new post-operative nerve palsies, and decreased range of motion (ROM) at final follow-up. ROM was measured by the attending surgeon or orthopedic resident in clinic; as this was a retrospective review the methods of measurement could not be standardized. Decreased ROM was considered a complication when the elbow did not have functional ROM of 30 degrees extension to 130 degrees flexion. In addition, we divided the complications into major and minor complications. Major complications included implant failure, fracture displacement, and persistent nerve palsy. Minor complications included delayed union, nonunion not requiring reoperation, implant prominence, and decreased ROM.

Covariate effect on rates of implant failure and rates of overall complication were assessed using independent $t$ tests for continuous variables and Chi-Squared analysis or Fisher exact tests for categorical variables.

### 3. Results

Thirty four patients with 35 fractures met the inclusion criteria. 67.6% (23/34) of patients were male and 32.4% (11/34) were female. Average age at time of injury was 12 years (range: 8–16, SD: 2.2). Average BMI was 19.7 (range: 14.7–29.2, SD: 3.7). Time from injury to surgery was a mean of 2.9 days (range: 0–12, SD: 3.4). Length of follow-up was a mean of 219.9 days (range: 23–1100 days, SD: 205.4 days). Mean displacement for all fractures was 10.9mm (range: 5–23.6mm, SD: 3.9mm). Twenty one of the 35 (60%) had an associated elbow dislocation, of which 25.7% ($n=9/35$) had an incarcerated fragment and 34.2% ($n=12/35$) had a dislocation without an incarcerated fragment. One fracture (3%) was comminuted (Tables 1 and 2).

The following implant constructs were used for operative fixation: 62.9% ($n=22/35$) using screws, 25.7% ($n=9/35$) using screws and washers, and 11.4% ($n=4/35$) using K-wires (Table 3).

Time to radiographic healing was a mean of 69 days postoperatively (range: 17–263, SD: 46.7). Return to full activity was seen in 91.4% ($n=32/35$) at a mean time of 105.9 days (range: 38–263, SD: 53.8). Three patients (8.5%) did not have a recorded date for return to full activity, but were followed for 41, 59, and 120 days (Table 4). Patients who had delayed or nonunion (11.4%, $n=4/35$) experienced a longer return to full activity (192.8 days, range: 60–263, SD: 79.5; $P<.001$).

There were 16 complications in 15 fractures (45.7%, $n=16/35$). Eight were implant complications, including prominence requiring reoperation (17.1%, $n=6/35$), implant failure (2.9%, $n=1/35$), and fracture displacement (2.9%, $n=1/35$). Other complications included nonunion (8.6%, $n=3/35$) or delayed union (2.9%, $n=1/35$; 263 days to radiographic healing), postoperative development of a persistent ulnar nerve palsy (5.7%, $n=2/35$), and decreased range of motion (5.7%, $n=2/35$). The patients with decreased ROM had motion of 45 degrees to 90 degrees and 30 degrees to 110 degrees at time of final follow-up (Table 3). There were 4 major complications and 12 minor complications.

Patient sex and BMI did not differ between those who developed complications and those who did not (males = 43.5% complications, females 63.6% complications, $P=.47$; BMI without complications = 20.0, BMI with complications = 19.3, $P=.61$). The patients who developed complications were younger than those who did not (no complication = 13.1 years, complication = 11.6 years, $P=.05$). Rates of major vs minor complications did not differ based on patient characteristics (sex: $P=.57$; BMI: $P=.85$, age: $P=.14$).

### Table 1

| Covariate | Total complications ($n=17$) |
|-----------|-----------------------------|
| Sex       |                             |
| Female    | 11                          |
| Male      | 23                          |
| Fracture Type |              |
| Comminuted | 1                          |
| Incarcerated | 9                          |
| Elbow dislocation alone | 12                      |
| Other     | 13                          |

| $P$ value |
|-----------|
| .47       |
| .09       |

### Table 2

| Covariate                   | Average | Range       | SD  | Association with complications: $P$ value |
|-----------------------------|---------|-------------|-----|-----------------------------------------|
| Age (years)                 | 12      | 8–16        | 2.2 | .95*                                    |
| BMI                         | 22.1    | 14.7–29.2   | 13.7| .61                                     |
| Degree displacement (mm)    | 10.9    | 5–23.6      | 3.9 | .57                                     |
| Time to surgery (days)      | 2.9     | 0–12        | 3.4 | .48                                     |
| Complication                | 2.5     | 0–12        | 3.6 |                                         |
| No complication             | 3.3     | 0–11        | 3.2 |                                         |

* statistically significant.

BMI = body mass index.
Table 3

| Complication          | N  | K-wire (n=4) | Screw and washer (n=9) | Screw alone (n=22) | Association of implant type with complication: P value |
|-----------------------|----|--------------|------------------------|-------------------|------------------------------------------------------|
| Implant               | 6  | 1            | 2                      | 5                 | 1.0                                                  |
| Prominence            | 6  | 0            | 2                      | 4                 |                                                      |
| Failure               | 1  | 0            | 0                      | 1                 |                                                      |
| Fracture displacement | 1  | 1            | 0                      | 0                 |                                                      |
| Other                 | 8  | 3            | 2                      | 4                 | .41                                                  |
| Nonunion              | 3  | 1            | 1                      | 1                 |                                                      |
| Persistent ulnar nerve palsy | 2  | 0            | 1                      | 1                 |                                                      |
| Decreased range of motion | 2  | 0            | 1                      | 1                 |                                                      |
| Delayed union         | 1  | 0            | 0                      | 1                 |                                                      |

Time to healing and return to sports.

| Average | Range     | SD | Association with complications: P value |
|---------|-----------|----|----------------------------------------|
| Time to healing (days) | 69 | 17–263 | 46.7 | .24 |
| Time to return to sports (days) | 105.9 | 38–263 | 53.8 | .69 |

SD = standard deviation.

Associated elbow dislocation or fragment incarceration were not associated with complication rate (P=.09). Displacement was 11.5 mm in patients who developed complications and 10.5 mm in those who did not, which was not significant (P=.57). Time to surgery was 2.5 days for fractures that developed complications versus 3.3 days for those that did not, which was not significant (P=.48). (Tables 1 and 2). Rates of major vs minor complications did not differ based on dislocation (P=.75), incarceration (P=1.0), displacement (P=.71), or time to surgery (P=.36).

Overall complication rates for the 3 types of fixation were: 75% (n=3/4) for K-wires, 44.4% (n=4/9) for screw and washer, and 40.1% (n=9/22) for screws alone. The differences between groups did not achieve statistical significance (P=.41). When examining implant complications by fixation type, 1 implant complication occurred in a fracture treated with K-wires (25%), n=1/4, 2 occurred in a screw and washer construct (22.2%, n=2/9), and 5 occurred in fractures treated with screws alone (22.7%, n=5/22). Rates of implant complication were not significantly different (P=1.0) between the 3 types of fixation (Table 3). Rates of major vs minor complications were not significantly different between the types of fixation (P=1.0).

Time to healing (P=.24) and return to sports (P=.70) were not significantly delayed in those who developed complications (Table 4).

4. Discussion

Medial epicondyle fractures in children treated with screw fixation have been reported with high rates of union, normal range of motion, and return to sports, and low rates of pain and valgus instability with this technique. However, there is little data on rates of implant failure using these techniques and most report on a small series of patients. In a study of 13 patients, Tarallo et al reported 3 cases of screw prominence and 1 lesion of the distal triceps myotendinous junction caused by a protruding screw tip. While Case and Hennrikus recommended the use of a screw and washer construct in order to minimize complications such as epicondyle fragmentation or penetration, Pace and colleagues found no difference in complication rates between screw fixation with and without a washer in a series of 17 patients.

In our series, 4 cases were stabilized using K-wires, and these occurred early in the study period (2003–2006). Although this study is underpowered to detect a difference between K-wire and screw stabilization, there was a 75% overall complication rate with K-wires versus a 22.6% rate with screw fixation. The complications associated with K-wires were fracture displacement (1), nonunion (1), and decreased ROM (1). While these are not complications found exclusively with K-wires, it is possible that the reduced compression provided by the wires vs screws allowed the fractures to displace and possible delayed healing. Admittedly, this group of patients is very small at only 4 patients. Thus, any results must be interpreted with caution. However, given that there was a complication with every patient, we feel it is worthwhile to present this data. Having said that, we would advise caution before proceeding with K-wire fixation.

While the rate of implant removal was higher in fractures treated with a washer (44.4%, n=4/9) than those treated with screws alone (27.3%, n=6/22) this did not achieve statistical significance (P=.42). While this series is larger than a majority that have previously reported on the topic, it is likely still underpowered in regard to this issue. It is also worth noting that there is some question as to whether removal of an implant after the fracture is healed should be considered a complication. Most of these patients are active in athletic activities and many families and/or surgeons may prefer to remove the implant. This in large part accounted for the higher complication rate reported in this series and may in fact be considered an anticipated part of the treatment course by many. In a series of 23 operatively treated patients by Lee et al, 23 had their implants removed, 2 of which were K-wires. Nonetheless, it requires an additional anesthetic and cost to the healthcare system. For that reason, we thought it was worthwhile to compare the groups with and without a washer. However, based on our current data we feel we are unable to strongly recommend 1 technique over the other.

In addition, while the rates of non-union (8.6%, n=3/35) and delayed union (2.9%, n=1/35) were higher than expected, these
patients eventually returned to their pre-injury activities. However, they did have a longer than average delay between surgery and return to activities than those who did not have delayed or non-union (192 days vs 106 days). This study is limited in the lack of a non-operative comparison group to better evaluate this issue.

Prior studies on the surgical treatment of medial epicondyle fractures have reported complication rates ranging from 0% to 41%, with the most commonly reported complication being screw prominence. The results of our study seem to be in line with these reports. The overall complication rate in our study was 48.6% (n=17/35), with an implant complication rate of 22.8% (n=8/35). Of the reported implant complications, 66.7% (n=6/9) were caused by screw prominence. Fixation with a screw alone had a higher overall complication rate than fixation with a screw and washer construct (50% vs 33%), although this was not statistically significant (P=.46). In contrast to a prior study, rates of screw prominence were twice as high in the screw alone group (22.7%, n=5/22) as in the screw and washer group (11.1%, n=1/9). This may be due to the surgeon not tightening the screw as aggressively if a washer is not present to minimize the chance of over-penetration or fracture fragmentation, though that cannot be established from a retrospective review.

Of interest, we also had 2 incidences (5.7%) of persistent ulnar nerve palsy. These cases occurred in a patient treated with a single screw and a patient treated with a single screw and washer. The palsy in the patient treated with a screw and washer resolved without further intervention within 7 months of the index procedure. The case occurring in the patient treated with a single screw was still symptomatic at last follow-up, although this did not prevent them from returning to their previous activities. This is a slight increase over the 4.5% rate reported in a meta-analysis of 287 operatively treated medial epicondyle fractures. Neither of the ulnar nerve palsies occurred in fractures with an incarcerated fragment nor an elbow dislocation. This is unusual in the literature, as typically nerve symptoms are associated with dislocation.

This study demonstrated that patient age was a factor in the overall complication rate. Patients who developed complications were, on average, 2 years younger than those who did not (no complication = 13.1 years, complication = 11.6 years, P=.05) (Table 2). In particular, patients who developed implant complications were approximately 1.5 years younger than those who did not, but the numbers in this study were too small to achieve statistical significance (P=.11). Implant complications may be more prevalent in younger patients due to the relative size of the screw—in this study the same size screw was used in all patients regardless of differing elbow sizes.

This study has several limitations. While our series is larger than those previously reported in the literature, our sample size was relatively underpowered and thus prevented some variables from reaching statistical significance. Additionally, we did not analyze a comparative non-operative group. There were several reasons for this. One was that many of the non-operative patients are lost to follow-up. Secondly, as our institution is generally conservative in their management of these fractures, those that are fixed tend to have a higher degree of injury, displacement and are typically in more athletic patients. It is possible that rates of nerve palsy, delayed union, and non-union may have been similar or higher in fractures treated non-operatively though we cannot determine that in this study. Finally, this study is limited by its retrospective nature. It is difficult to determine exact dates of healing and return to activity through chart review and it is possible that the data range for these variables is caused, in part, by the lack of precision of this review method.

Although one quarter of skeletally immature children with medial epicondyle fractures experienced an implant issue and overall complication rate approached 50%, the majority of complications were minor and nearly all of patients in this study were able to return to full activity with no restrictions. Approximately 20% of medial epicondyle fractures treated with screws eventually had the screws removed due to symptomatic prominence. Patients and parents should be carefully counseled preoperatively on the high likelihood of implant prominence and the eventual need for a second surgery, but they may be reassured by the high rate of return to previous activity.

Author Contributions

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