Published in final edited form as:

Clin J Sport Med. 2020 November ; 30(6): e214–e218. doi:10.1097/JSM.0000000000000666.

No Difference in Return to Sport and Other Outcomes between Operative and Non-Operative Treatment of Medial Epicondyle Fractures in Pediatric Upper-Extremity Athletes

Derek Paul Axibal, MD^{1,2}, Patrick Carry, MS², Anne Skelton, BS², Stephanie Watson Mayer, MD^{1,2}

¹University of Colorado Hospital Department of Orthopaedic Surgery, Aurora, CO, USA

²Children's Hospital of Colorado, Department of Orthopedic Surgery, Aurora, CO USA

Abstract

Objective: Compare outcomes of operative and non-operatively managed medial epicondyle fractures in upper-extremity athletes.

Design: Retrospective chart review and phone survey.

Setting: Level 1, tertiary-referral pediatric hospital.

Patients: Propensity scores (probability of operative treatment) were estimated from a logistic regression model that included gender, age, displacement, limb dominance, and injury severity (presence of an additional fracture, nerve injury, or elbow dislocation). These were used to match subjects in the operative group to the non-operative group.

Main Outcome Measures: Return to sport, duration of time required to return to sport, pain, range of motion, need for physical therapy, and complications were recorded for both groups.

Results: 28 non-operative subjects were matched to 14 operative subjects. There was no significant difference in the proportion of subjects that returned to the same sport (92.9% in each group), performance at pre-injury level of competition, or median time to return to play ($p = 0.7106$). There was no significant difference in functional limitations in social/ work related activities ($p > 0.9999$), pain in the last 30 days ($p = 0.0640$), need for physical therapy ($p = 0.5680$), range of motion limitations ($p = 0.0988$), difficulty sleeping ($p = 0.4773$), or complications ($p = 0.4081$).

Conclusions: Our study found no statistical difference in outcomes or complications between operative and non-operatively treated moderately displaced medial epicondyle fractures in adolescent upper-extremity athletes. Our data shows similar outcomes may be achieved with both treatment groups for medial epicondyle fractures in upper-extremity athletes.

Corresponding Author: Derek Axibal, MD, Derek.axibal@ucdenver.edu, University of Colorado Hospital Department of Orthopaedic Surgery, 12631 E. 17th Avenue, Mail Stop B202, Aurora, CO 80045, Mobile 224.622.1300.

Conflicts of interest and sources of support: None

Keywords

Medial epicondyle fracture; pediatric elbow fracture; distal humerus fracture; fracture; athlete; return to play

INTRODUCTION

The medial epicondyle apophysis is located posteromedially on the distal humerus. It functions as the origin for both the ulnar collateral ligament and flexor-pronator mass.[1] The ossification center emerges at about 5–7 years of age and fuses at about 15–20 years of age.[2] Fractures of the medial epicondyle usually occur at about 9–14 years of age, as the incompletely ossified bone is susceptible to earlier failure than the more robust soft tissue attachments.[3]

Optimal treatment for pediatric medial epicondyle fractures continues to be a topic of debate. Generally accepted operative indications include incarcerated fragments, open fractures, and ulnar nerve injuries.[3,4] Controversy lies in the acceptable amount of fracture displacement, as authors have recommended surgical intervention for fractures with widely variable displacement. Hines et al. proposed operative management for fractures displaced more than 2 mm, Woods et al. recommended surgery for displacement greater than 10 mm, while Josefsson et al. reported “good” range of motion and function with non-operative treatment of fractures displaced up to 15 mm.[5–7] In a relevant retrospective study of moderately displaced medial epicondyle fractures in the general pediatric population, the current authors found no statistical differences in outcomes between operative (N=22) and non-operatively (N=22) treated subjects (currently under review; derek.axibal@ucdenver.edu). Outcomes included: length of immobilization, time to full range of motion (flexion/extension and pronation/supination), need physical therapy, and complications.

Of particular importance are medial epicondyle fractures that occur in upper extremity athletes.[8] The anterior band of the ulnar collateral ligament is the most important ligamentous stabilizer to valgus stress in the elbow, whereas the flexor-pronator mass plays a significant role in dynamic/ muscular stabilization.[3,9] As these static and dynamic stabilizers attach to the medial epicondyle, valgus stress in a skeletally immature athlete is transferred to the medial epicondyle physis. With non- or malunion of the medial epicondyle, valgus instability may ensue; a functionally catastrophic result for upper-extremity athletes who rely on elbow stability for their sport.[9]

The literature is scarce regarding the outcomes of operative versus non-operatively managed athletes with these injuries. Lawrence et al. reported the results of 14 overhead athletes with medial epicondyle fractures (6 non-operative and 8 operative patients). Excellent DASH (Disabilities of the Arm, Shoulder and Hand) scores were achieved in both treatment groups. [8] However, there are no other published comparative studies in adolescent, upper-extremity athletes with these injuries. Some authors recommend surgical treatment for upper-extremity athletes that require elbow stability to participate in their sport. Woods et al. recommends surgery if the medial epicondyle fracture occurs in “the throwing arm.”[6] Cruz

et al. considers open reduction internal fixation if there is greater than 25% anterior displacement relative to the fracture bed.[9]

The purpose of this study was to compare the outcomes and complication rates between operative and non-operative treatment of moderately displaced medial epicondyle fractures in upper extremity athletes.

METHODS

With approval from the Institutional Review Board (IRB), a retrospective chart review and phone survey were performed to collect data from adolescent athletes treated for an acute, medial epicondyle fracture between 2005 and 2015 at our Level 1, tertiary-referral pediatric hospital (N=152). Acute fractures were defined as those treated within 14 days of injury. Subjects without a baseline x-ray (n=9), and fractures which were chronic (i.e.- epiphysiolysis with displacement), open, incarcerated (n=10), bilateral (n=1), or non-displaced, were excluded from the study. Non-athletes and non-upper extremity athletes were excluded (soccer, running, high/ long jump, snowboarding, etc.) (n=4). Football was considered to be an upper-extremity sport as the arms are used for blocking, tackling, and throwing. The phone survey included questions related to pain, range of motion, and duration of time required to play following the initial injury. Subjects that did not complete the phone survey were also excluded (n=31).

Demographic data including age, gender, limb dominance, and associated injury characteristics, such as additional fracture, nerve injury and dislocation, were all obtained. Fracture displacement on AP and lateral x-rays were measured by a single orthopedic surgery resident (DPA). The larger of the two values was used. The treatment types were classified as operative or non-operative based on the initial treatment decision. The phone survey included questions regarding return to sport, duration of time required to return to sport following the initial injury, pain, range of motion, need for physical therapy, and problems related to sleeping, work, or social activities. Complications were also recorded for both groups.

Standardized mean differences were used to compare subjects in the two groups that met the initial inclusion criteria. (Table 1) Propensity scores were used to balance the distribution of covariates in the two groups. Propensity scores, or the predicted probability of operative treatment, were estimated from a logistic regression model that included gender, age, displacement, limb dominance, and injury severity (presence of an additional fracture, nerve injury, or concomitant elbow dislocation). A log transformation was applied to fracture displacement as this variable was positively skewed. Variables were selected for the propensity model based on a priori assumptions about their relevance to surgical decision making. (Table 1) Subjects in the operative group were matched to subjects in the non-operative group using a greedy, nearest neighbor, matching algorithm (implemented using the MatchIt R package). The caliper width was set to 0.2 standard deviations. Due to the small sample size, the number of non-operative subjects matched to each operative subject included in the study ranged between 1 and 3. Cox-proportional hazards regression analyses were used to compare time to return to play in the two groups. Logistic regression analyses

(SAS 9.4) were used to test for group differences in the prevalence of subjects reporting pain in the past 30 days as well as differences in the cumulative incidence of complications. All analyses were weighted to account for differences in the number of control subjects (range 1–3) included in each of the matching strata.

RESULTS

85 subjects met the inclusion criteria. Prior to matching, subjects in the operative group tended to be male, older, and presented with a greater amount of fracture displacement. (Table 1) The final cohort included 28 subjects in the non-operative group matched to 14 subjects in the operative group. After matching, there was no difference in the baseline characteristics between the two groups ($p > 0.05$ and $SMD = 0.15$). (Table 1) All subjects were involved in sports which use upper-extremity function. Football was the most common sport in both treatment groups, although most athletes reported participating in multiple sports. (Table 2) The median follow-up at the time of phone interview for the matched cohort was 43 months for the non-operative group (interquartile range: 22–60 months) and 52 months for the operative group (interquartile range 30–69 months). The geometric mean displacement in both groups was 6.05 millimeters in the matched sample.

The proportion of subjects that returned to the same sport was similar in the non-operative (92.9%; 26/28) and operative (92.9%; 13/14) groups ($p > 0.9999$). All subjects in both groups that did return to the same sport reported they performed at their pre-injury level of competition ($p > 0.9999$). Regarding patients that did not return to the same sport (operative $n=1$; non-operative $n=2$), they reported switching from an upper-extremity sport (operative: volleyball; non-operative: volleyball and softball) to one that was less demanding on the upper-extremity (i.e.- soccer). Non-operative patients tended to return to play (median time: 3 months; 95% CI: 3–6 months) sooner than those in the operative group (median time: 5.5 months; 95% CI: 3–6 months). This was not statistically significant (Hazard Ratio: 0.9, 95% CI: 0.5–1.7, $p = 0.7106$); there was no difference in hazard of a delay in return to play in the operative group relative to the non-operative group.

All subjects in both groups reported no functional limitations in social or work related activities ($p > 0.9999$). There was no difference between the operative group and the non-operative group with respect to presence of self-reported elbow pain in the last 30 days (OR: 4.6, 95% CI: 0.9–23.4, $p = 0.0640$), need for physical therapy/ occupational therapy (OR: 1.6, 95% CI: 0.3–7.0, $p = 0.5680$), self-reported range of motion limitations (motion of affected limb is less than motion in unaffected arm) (OR: 3.7, 95% CI: 0.8–17.4, $p = 0.0988$), or difficulty sleeping (OR: 3.2, 95% CI: 0.1–75.0, $p = 0.4773$). (Table 3)

Lastly, although complications in the non-operative group ($N=6$) tended to be higher compared to the operative group ($N=1$), there was no difference in the cumulative incidence of post-treatment complications (OR: 0.4, 95% CI: 0.1–3.7, $p = 0.4081$). Complications in the non-operative group included: malunion ($N=2$), loss of reduction + non-union that required surgery ($N=1$), severe range of motion limitations ($N=1$), post-casting numbness/ tingling ($N=1$), and repeat dislocation ($N=1$). Both malunion patients were symptomatic, and necessitated physical therapy. One subject in the operative group sustained new onset, post-

operative numbness/ tingling that was still present at the time of the latest follow-up. Three operative subjects required symptomatic hardware removal; these were not considered in the complications analysis as this outcome is not unexpected. Although hardware removal has the potential to impact or delay return to sport, hardware is oftentimes removed one year after surgery, after the patient has initially returned to sport.

DISCUSSION

Fractures of the medial epicondyle are common in the pediatric population, accounting for up to 20% of all elbow injuries. Males represent up to three-fourths of these injuries.[3] As many of the structures that resist this valgus stress originate on the medial epicondyle, bony union is important for preserving standard elbow mechanics and therefore sports performance in athletes.[9]

The literature is conflicting in regards to the optimal treatment of medial epicondyle fractures in the general pediatric population. Furthermore, there is a significant lack of data pertaining specifically to upper-extremity athletes with only two papers specifically focusing on this group.[8,10] Our study provides a more balanced comparison of the outcomes and complications between operative and non-operative management of medial epicondyle fractures in this patient population.

In order to control for confounding factors between the operative and non-operative groups, a propensity-matched analysis (probability of receiving operative treatment) was performed. Demographics such as age, displacement, injury severity (additional fracture, nerve injury or dislocation), and limb dominance were used to match subjects as surgeons are more likely to operate on older patients and fractures associated with increased fracture displacement, additional injuries, or dominant extremities. The propensity-matched analysis provided well-matched cohorts, granting a more direct comparison of operative versus non-operative treatment. However, this analysis also greatly decreased our final sample size.

We found no difference in the proportion of upper-extremity athletes that returned to the same sport (92.9% in each group; $p > 0.9999$). All subjects that returned to sport did so at their pre-injury level of competition ($p > 0.9999$). These results are somewhat similar to Lawrence et al.'s analysis of medial epicondyle fractures in overhead athletes. They reported no difference in return to sport (8/8 operative patients and 6/6 non-operative patients). 1 of the 8 operative patients reported limited performance in football and basketball; however, no statistical analysis was performed.[8] Osbahr et al. also found good results in youth baseball players treated for this injury, although treatment was generally based upon displacement. All patients with < 5 mm of displacement treated non-operatively ($N=5$) and all patients with > 5 mm of displacement treated with surgery ($N=3$) returned to sport.[10]

Median time to return to play tended to be lower in the non-operative group (3 months) compared to the operative group (5.5 months); however, this was not statistically significant. This could be multifactorial. The idea and gravity of surgery could have psychology delayed some families from returning to sport. Also, the clearance of return to play is left to the discretion of the treating surgeon. Finally, the study sample size may not be large enough to

detect such a difference. Osbahr et al. found differing results: operative baseball players tended to return to sport earlier (6.3 months) compared to the non-operative group (8.4 months), although no statistical analysis was reported.[10] Lawrence et al. did not report on time required before returning to play.[8]

In regards to functional limitations in social or work related activities ($p > 0.9999$), pain in the last 30 days ($p = 0.0640$), need for physical therapy/ occupational therapy ($p = 0.5680$), range of motion limitations ($p = 0.0988$), or difficulty sleeping ($p = 0.4773$), there was no statistically significant difference between the operative and non-operative managed upper-extremity athletes. Although the non-operative group tended to perform better in each of the aforementioned outcomes, the study may not be sufficiently powered to detect these differences. Although Lawrence et al. did not report these outcomes specifically in overhead athletes, these outcomes were analyzed in subjects who “participated in at least 1 competitive sport on a regular basis.” They found half of each cohort required therapy, about 1/3 of each treatment group had a perceived residual loss of elbow range of motion, and one non-operative patient who reported pain. [8]

Although the incidence of post-treatment complications tended to be lower in the operative cohort (operative: $N=1$; non-operative: $N=6$), our data found no difference between both groups ($p = 0.4081$). Of note, three operative subjects required a second surgery due to symptomatic hardware removal. However, these second surgeries were not considered in our analysis. These results are somewhat similar to the complications reported by Lawrence et al. In patients who participated in at least one sport (not specifically overhead athletes), all healed with bony union without any growth disturbances of the distal humerus. Six operative subjects and one non-operative subject had occasional and episodic numbness.[8] Osbahr et al. reported no complications in either treatment group in youth baseball players.[10]

There are several limitations to our study, many stemming from the retrospective design. With regards to the telephone survey, there is potential for recall bias, as our upper-extremity athletes and their parents were asked to recall experiences that occurred over 3.5 years prior (i.e.- time to return to play, need for physical therapy, etc.). Additionally, as we were unable to examine each subject at final follow-up, the range of motion limitations were self-reported, and therefore not measured in degrees, but rather compared to the uninjured elbow. In regards to displacement measurement, there are more accurate means of measuring medial epicondyle fractures (rather than an AP/ lateral xray). However, as most of the patients in our study were initially seen in the emergency department, oftentimes, only standard AP and lateral films were obtained.[11–13] Additionally, our study used one orthopedic surgery resident to measure fracture displacement. Our data would be strengthened with intra and inter-rater reliability. Furthermore, although this is one of the largest studies of medial epicondyle fractures in upper-extremity athletes, our sample size is still small; larger, prospective studies are needed. Lastly, other considerations such as contact versus non-contact sport or limb dominance could also affect outcomes. Limb dominance plays a key-role in throwing athletes such as baseball players or quarterbacks, but excluding injuries of non-dominant limbs would greatly reduce our sample size.

About 45 million children, adolescents, and teens participate in organized sports in the US every year.[14,15] As single-sport concentration and organized sports occur at a younger age, young athletes are vulnerable to an array of elbow injuries.[10] With this, the appropriate treatment of injuries in youth athletes becomes ever more critical.

This data provides outcomes and complications of non-operative and operatively managed medial epicondyle fractures in upper-extremity athletes presenting to a large volume pediatric hospital over a ten-year period. In regards to moderately displaced fractures, we found no difference in the rate of return to sport, return to sport at the pre-injury level of competition, time to return to sport, functional limitations in social or work related activities, pain in the last 30 days, need for physical or occupational therapy, range of motion limitations, difficulty sleeping, or complications. With respect to “moderately” displaced fractures, using the standard deviation from our data provides a range of 4.25–7.8 millimeters. These results should not be extended to nondisplaced fractures, significantly displaced fractures, or those with clear indications for surgery (i.e.- open or incarcerated fractures). Additional, long-term studies with larger cohorts and functional outcomes, as well as randomized clinical trials, will continue to improve treatment algorithms for these injuries.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

REFERENCES

1. Pathy R, Dodwell ER. Medial epicondyle fractures in children. *Curr Opin Pediatr* 2015; 27(1):58–66. [PubMed: 25564187]
2. Gottschalk HP, Eisner E, Hosalkar HS. Medial epicondyle fractures in the pediatric population. *J Am Acad Orthop Surg* 2012; 20(4):223–232. [PubMed: 22474092]
3. Beck JJ, Bowen RE, Silva M. What’s New in Pediatric Medial Epicondyle Fractures? *J Pediatr Orthop* 2016.
4. Ip D, Tsang WL. Medial humeral epicondylar fracture in children and adolescents. *J Orthop Surg (Hong Kong)* 2007; 15(2):170–173. [PubMed: 17709855]
5. Hines RF, Herndon WA, Evans JP. Operative treatment of Medial epicondyle fractures in children. *Clin Orthop Relat Res* 1987; (223):170–174.
6. Woods GW, Tullos HS. Elbow instability and medial epicondyle fractures. *Am J Sports Med* 1977; 5(1):23–30. [PubMed: 848632]
7. Josefsson PO, Danielsson LG. Epicondylar elbow fracture in children. 35-year follow-up of 56 unreduced cases. *Acta Orthop Scand* 1986; 57(4):313–315. [PubMed: 3788492]
8. Lawrence JT, Patel NM, Macknin J, Flynn JM, Cameron D, Wolfgruber HC, et al. Return to competitive sports after medial epicondyle fractures in adolescent athletes: results of operative and nonoperative treatment. *Am J Sports Med* 2013; 41(5):1152–1157. [PubMed: 23507792]
9. Cruz AI, Steere JT, Lawrence JT. Medial Epicondyle Fractures in the Pediatric Overhead Athlete. *J Pediatr Orthop* 2016; 36 Suppl 1:S56–62. [PubMed: 27100037]
10. Osbahr DC, Chalmers PN, Frank JS, Williams RJ, Widmann RF, Green DW. Acute, avulsion fractures of the medial epicondyle while throwing in youth baseball players: a variant of Little League elbow. *J Shoulder Elbow Surg* 2010; 19(7):951–957. [PubMed: 20688542]
11. Edmonds EW. How displaced are “nondisplaced” fractures of the medial humeral epicondyle in children? Results of a three-dimensional computed tomography analysis. *J Bone Joint Surg Am* 2010; 92(17):2785–2791. [PubMed: 21123608]

12. Gottschalk HP, Bastrom TP, Edmonds EW. Reliability of internal oblique elbow radiographs for measuring displacement of medial epicondyle humerus fractures: a cadaveric study. *J Pediatr Orthop* 2013; 33(1):26–31. [PubMed: 23232375]
13. Souder CD, Farnsworth CL, McNeil NP, Bomar JD, Edmonds EW. The Distal Humerus Axial View: Assessment of Displacement in Medial Epicondyle Fractures. *J Pediatr Orthop* 2015; 35(5):449–454. [PubMed: 25171678]
14. Fishman M, Taranto E, Perlman M, Quinlan K, Benjamin HJ, Ross LF. Attitudes and Counseling Practices of Pediatricians Regarding Youth Sports Participation and Concussion Risks. *J Pediatr* 2017; 184:19–25. [PubMed: 28238481]
15. Wong TT, Lin DJ, Ayyala RS, Kazam JK. Elbow Injuries in Pediatric Overhead Athletes. *AJR Am J Roentgenol* 2017:1–11.

Table 1.

Demographics and clinical characteristics before and after matching.

	Non-Operative N=64		Operative N=21		P value	SMD	Non-Operative N=28		Operative N=14		P value	SMD
Additional Fracture, N (%)	19	29.69%	10	47.62%	0.1326	-0.37	12	42.86%	5	35.71%	>0.9999	-0.14
Nerve Injury, N (%)	3	4.69%	3	14.29%	0.1574	-0.33	2	7.14%	1	7.14%	>0.9999	0
Dislocation, N (%)	13	20.31%	9	42.86%	0.0407	-0.49	8	28.57%	5	35.71%	>0.9999	0.15
Female Gender, N (%)	24	37.50%	3	14.29%	0.0474	0.54	2	7.14%	1	7.14%	>0.9999	0
Dominant Limb, N (%)	10	15.63%	2	9.52%	0.7216	0.18	5	17.86%	2	14.29%	>0.9999	-0.09
Age, Mean (Stdev)	12.5	2.5	13.6	1.9	0.0419	0.5	13.3	2.7	13.3	2.2	0.964	-0.01
Distance [millimeters], Mean (Stdev.)	3.81	2.03	5.33	1.78	0.0009	2.16	6.05	1.78	6.05	1.02	0.8771	-0.13

*SMD = standardized mean difference

Table 2.

Distribution of sports participation

	Non-Operative * N=28		Operative * N=14	
Baseball, N (%)	8	28.6%	2	14.3%
Basketball, N (%)	5	17.9%	3	21.4%
Cheerleading, N (%)	0	0.0%	2	14.3%
Football, N (%)	15	53.6%	6	42.9%
Gymnastics, N (%)	2	7.1%	0	0.0%
Lacrosse, N (%)	3	10.7%	2	14.3%
Racquetball, N (%)	1	3.6%	0	0.0%
Weightlifting, N (%)	0	0.0%	1	7.1%
Wrestling, N (%)	3	10.7%	4	28.6%

* Athletes participated in multiple sports

Table 3.

Outcomes between non-operative and operative treatment groups.

	Non-Operative (N=28)		Operative (N=14)		p-value
Return to sport, N (%)	26	92.9%	13	92.9%	>0.9999
Time to Return to sport, months (CI)	3	3–6	5.5	3–6	0.7106
Pain in the last 30 days, N (%)	3	10.7%	5	35.7%	0.0640
Need for physical therapy, N (%)	20	71.4%	11	78.6%	0.5680
ROM Limitations, N (%)	4	14.2%	5	35.7%	0.0988
Sleep difficulty, N (%)	1	3.5%	1	7.1%	0.4773
Complications, N (%)	6	28.1%	1	7.1%	0.4081
Limitation in social/ work, N (%)	0	0.0%	0	0.0%	>0.9999