

# Clinical Outcomes and Return to Play in Youth Overhead Athletes After Medial Epicondyle Fractures Treated With Open Reduction and Internal Fixation

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**Background:** There is limited literature regarding outcomes after operative treatment of displaced medial epicondyle avulsion fractures in adolescent athletes. Most studies have had a relatively small sample size and have not assessed return to play of the overhead athlete.

**Purpose:** To examine return to play and outcomes of youth overhead athletes who underwent open reduction and internal fixation (ORIF) with screw fixation.

**Study Design:** Case series; Level of evidence, 4.

**Methods:** Charts and radiographs were queried between January 2003 and June 2018 for young overhead athletes (age, <17 years) who underwent ORIF for displaced medial epicondyle fracture. Patients with open fracture or concomitant injury were excluded. Radiographs from postoperative follow-up visits were examined for radiographic union. Eligible patients were asked to provide responses to the American Shoulder and Elbow Surgeons Standardized Assessment Elbow questionnaire and Kerlan-Jobe Orthopaedic Clinic questionnaires as well as questions regarding return to play.

**Results:** Overall, 29 patients were included in the study; the mean age at surgery was 14.7 years (range, 12.9-16.5 years). There were 25 baseball players, 3 football quarterbacks, and 1 tennis player. Of the 23 patients with available images at least 3 months after surgery, 96% demonstrated radiographic union at last follow-up. Imaging for the 1 patient with nonunion was taken 3 months after ORIF, and it is unknown if he eventually had union. All patients (100%) were successfully contacted to complete questionnaires at a mean follow-up of 4.8 years (range, 1.0-13.5 years). The mean KJOC score was 93.0, and the mean scores for the American Shoulder and Elbow Surgeons Elbow questionnaire were 8.9, 35.6, and 9.8 for pain, function, and satisfaction, respectively. One overhead athlete did not return to play, while the other 28 returned at a mean 7 months after surgery. No patient underwent revision ORIF, 1 underwent hardware removal, and 1 underwent ulnar nerve transposition. No players underwent ulnar collateral ligament reconstruction after primary ORIF of the medial epicondyle.

**Conclusion:** ORIF of displaced medial epicondyle fractures is a reliable and successful procedure in adolescent overhead athletes with high demands, with relatively low risk of major complications, reinjury, or reoperation.

**Keywords:** elbow fracture; avulsion fracture; baseball pitcher; adolescent athletes

Fractures of the medial epicondyle account for 12% of all pediatric elbow fractures and most frequently occur within the age range of 9 to 14 years.<sup>16</sup> Injuries to the medial epicondyle are more frequent in overhead athletes, and there has been a notable rise in young overhead throwing athletes.<sup>2</sup> The valgus load placed on the elbow in the overhead athlete leads to predictable injuries that have been

well documented in baseball players, with a specific propensity in pitchers.<sup>2</sup> Skeletally mature pitchers are at risk of rupturing the ulnar collateral ligament; however, injuries in the skeletally immature more commonly lead to apophysitis or a medial epicondyle fracture.<sup>14</sup>

Zellner and May<sup>17</sup> suggested that open reduction and internal fixation (ORIF) may be considered in the dominant arm of a thrower or gymnast because of the risk of nonunion and resultant valgus instability if untreated. Clear surgical indications for ORIF of medial epicondyle fractures include entrapped intra-articular medial epicondyle fragment,

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open fracture, or intra-articular extension. Relative indications are controversial and can include concomitant ulnar nerve dysfunction, associated elbow dislocation, significant fracture fragment displacement, and injuries in high-level throwing athletes. Erickson et al<sup>6</sup> studied the return to play and performance of professional baseball pitchers after ORIF of the medial epicondyle, seen as a sequela after ulnar collateral ligament reconstruction. They found that 73% were able to return to sport; however, only 55% were able to pitch at the same level or higher. While these studies have provided knowledge about ORIF of medial epicondyle fractures in professional overhead athletes, the efficacy in adolescent athletes is unknown. Study of adolescent athletes with epicondyle fractures has been limited to a case series of bony excision.<sup>4</sup> Thus, the objective of this study was to evaluate the outcomes of overhead adolescent athletes with medial epicondyle avulsion fractures treated using open reduction and screw fixation. We hypothesized that there would be a high percentage of return to play and high rates of subjective patient outcomes and radiographic union among this cohort.

## METHODS

After receiving institutional review board approval, we performed a retrospective review of the charts and radiographs of adolescent patients (age, <17 years) with medial epicondyle fracture between January 2003 and June 2018 who were treated using open reduction and screw fixation. Eligible patients were identified from our billing database utilizing the Current Procedural Terminology code for operative fixation of a medial epicondyle fracture. Only patients who were overhead athletes (baseball players, football quarterbacks, tennis players) were included. Football players who were not quarterbacks were excluded, as were patients who had their ORIF on the nondominant arm. All medial epicondyle fractures were treated by 1 of 3 attending surgeons (E.L.C., B.A.E., or J.R.D.) at our institution. Our criterion was any avulsion fracture with visible displacement seen on radiographic evaluation. The standard preferred treatment at our institution is a single cannulated 4.0-mm screw, which is sometimes augmented with a washer based on surgeon preference. Patients were excluded if they underwent fixation using suture anchors or percutaneous pin fixation.

In addition, we excluded those with open fractures, those with concomitant injuries to the ipsilateral upper extremity, and patients who were mentally incapacitated and would be unable to comply with postoperative protocols. Our postoperative physical therapy protocol started with placing the upper extremity in a posterior splint for the first 5 days to allow wound healing and edema control. One week after surgery, the patient began passive and active range of motion as well as light strengthening for the shoulder and scapula. Light strengthening exercises were initiated at week 3, and full passive range of motion was encouraged at 8 weeks. If the fracture was healed, the patient began more aggressive strengthening at 8 weeks and light throwing at 16 weeks. Patients were allowed to return to sports at 6 months after surgery. Some patients were advised not to pitch during their first season back in baseball.

The charts were reviewed to evaluate any documented complications or any revision surgical procedure performed. The most recent follow-up radiograph was also reviewed to assess for radiographic union or displacement of the fracture.

To assess clinical outcomes and return to play, patients were contacted via telephone, email, and/or letter and invited to participate in the questionnaire portion of the study. Investigators contacted the patient and obtained verbal consent for participation. If the patient was a minor at the time of questioning, parental consent was also obtained. The patient was then asked to answer questions from the American Shoulder and Elbow Surgeons Elbow questionnaire (ASES-E), Kerlan-Jobe Orthopaedic Clinic (KJOC) score, and a return-to-play questionnaire.

All identifying information was removed, and data points were recorded in an Excel (2012; Microsoft Corp) spreadsheet on a password-protected computer, compliant with institutional review board requirements. Statistical analysis was completed using JMP (Version 10; SAS Institute Inc). Descriptive statistics included mean, SD, and the minimum and maximum for each variable of interest. Inferential statistics utilized paired-samples *t* tests to compare pre- and postsurgery data ( $P < .05$ ).

## RESULTS

A total of 29 athletes were included in the study. All athletes were male. The mean age at the time of surgery for all

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Ethical approval for this study was obtained from Sterling Institutional Review Board.

TABLE 1

Distribution of Sports and Positions Among the 29 Patients

Sport and Position	No. (%)
Baseball	25 (86)
Pitcher <sup>a</sup>	21 (72)
Infielder	4 (14)
Outfielder	2 (7)
Catcher	1 (3)
Unknown	1 (3)
Football quarterback	3 (10)
Tennis player	1 (3)

<sup>a</sup>Four baseball pitchers also played another baseball position.

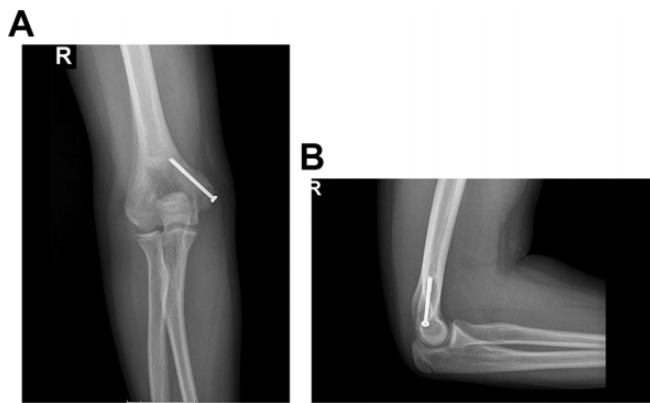


Figure 1. (A) Anterior and (B) lateral view radiographs for a patient with union.

patients was 14.7 years (range, 12.9-16.5 years). The majority of patients (86%) played baseball (Table 1).

Chart review revealed radiographic examinations available at least 3 months after surgery for 23 patients. The most recent images demonstrated union for 96% (22/23) of these patients. Imaging for the 1 patient with delayed union was taken 3 months after ORIF, and it is unknown if he eventually had union of his fracture. Sample radiographs for union and nonunion are shown in Figures 1 and 2, respectively. Among the 6 patients without radiographic images, 1 had a clinic note stating, “well fixed, well placed medial epicondyle fracture.”

All study participants (29/29) were successfully contacted and answered all 3 questionnaires. The mean ± SD time from surgery to follow-up was 4.8 ± 2.4 years (range, 1.0-13.5 years). At the time of follow-up, 48% (14/29) of the athletes were still active at a competitive scholastic level; 28% (8/29) were playing at an intramural or recreational level; and 24% (7/29) were no longer playing. Of the 7 who were inactive, 1 cited that his inactivity was due to difficulty with his operative arm, whereas the remainder were either unable to play at the next level or decided to stop for personal reasons. The highest level achieved by the time of follow-up was collegiate for 28% (8/29), high school for 69% (20/29), and middle school for 3% (1/29).

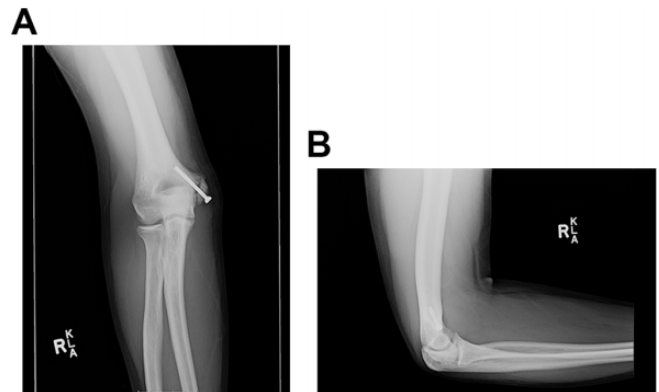


Figure 2. (A) Anterior and (B) lateral view radiographs 3 months postoperatively for a patient with delayed union.

TABLE 2  
Subjective Outcomes (N = 29)<sup>a</sup>

Questionnaire: Scale	Mean ± SD	Range
KJOC, 0-100	93.0 ± 11.7	43-100
ASES-E		
Pain, 5-50	8.9 ± 6.3	5-25
Function, 0-36	35.6 ± 1.4	30-36
Satisfaction, 1-10	9.8 ± 0.5	8-10

<sup>a</sup>ASES-E, American Shoulder and Elbow Surgeons Elbow; KJOC, Kerlan-Jobe Orthopaedic Clinic.

One baseball pitcher did not return to play, while the remaining 97% (28/29) of the overhead athletes returned to their previous levels of their sport. The mean time to return to competition was 7 months (range, 2-17 months) among the 28 overhead athletes who returned to sport and likewise 7 months (range, 3-13 months) among the subgroup of 20 baseball pitchers who returned. Mean self-reported fastball velocity among the baseball pitchers increased significantly ( $P < .05$ ), from 76 mph preinjury to 83 mph postsurgery. One patient stated that he was forced to change position from pitcher to outfielder because of his surgery, and another patient stated that he voluntarily transitioned from starting pitcher to relief pitcher.

The KJOC questionnaire is used to assess perceived health in overhead athletes. Scores range from 0 (lowest level of perceived health) to 100 (highest level). The mean KJOC score among our overhead athletes was 93.0. The 1 athlete who did not return to play had a score of 43, while the other 26 had scores ranging from 70 to 100. Excluding the 1 athlete who did not return to play, the mean KJOC score was 95.

ASES-E is used to assess a patient’s level of pain, function, and satisfaction. Pain scores range from 0 (no pain) to 50 (worst pain ever). The mean ASES-E pain score among our overhead athletes was 9. ASES-E function scores range from 0 (least amount of functionality) to 36 (greatest functionality). The mean function score in our series was 35.6. Satisfaction with the surgery is scored on a scale of 1 to 10, with 1 being not pleased with surgery and 10 being pleased.

Our patients had a mean satisfaction score of 9.8. KJOC and ASES-E outcome scores are shown in Table 2.

We observed minor complications, with a low rate of reoperation and reinjury. Our observed complications included unintended retained hardware: a broken Kirshner wire for provisional fixation noted intraoperatively was left in the distal humerus, as it was believed to be clinically insignificant. No player experienced hardware failure or underwent revision ORIF. We noted a low rate of hardware removal (3%; 1/29). One player experienced ulnar neuritis and later underwent ulnar nerve transposition. Two (7%) athletes were diagnosed with a strain of the ulnar collateral ligament/pronator after their index procedure. Both of these patients were treated nonoperatively. Of note, no player underwent operative intervention for an ulnar collateral ligament tear after the initial ORIF surgery. Four (14%) players later experienced injuries to the operative arm, including 3 labral/superior labrum anterior-posterior tears. Of these 3 tears, 1 was treated operatively, and 2 were treated via physical therapy. One patient underwent surgical treatment for his Bennett lesion via posterior capsular release, as well as a repeat shoulder arthroscopy the following season to address impingement in his dominant shoulder. These shoulder injuries may have been related to the same biomechanics that caused the medial epicondyle avulsion fracture. It has been well described that up to 20% of patients who undergo ulnar collateral ligament reconstruction later require shoulder surgery.<sup>1,13</sup>

## DISCUSSION

### Return to Play

As hypothesized, return to play, subjective outcomes, and radiographic outcomes were very good, and 97% of our overhead athletes (28/29) returned to play. The case series of Lawrence et al<sup>10</sup> including 14 overhead athletes (8 treated operatively and 6 treated nonoperatively) showed a return to play of 100% with no limitations after treatment. Case and Hennrikus<sup>3</sup> reported 100% (8/8) return to sport. Their patients were allowed to return without restrictions 12 weeks after surgery. They recommended screw and washer fixation, which helped provide anatomic fixation and the benefit of early mobilization, over the previously described Kirshner wire percutaneous fixation. These results may vary from our findings, given their smaller sample size, younger patient population, and the fact that only 5 of 8 athletes had injury to the dominant arm. Also, all patients in that study experienced injury as a result of a fall, while the large majority of patients in our study had noncontact acute avulsion fractures while performing overhead athletic activities, such as baseball pitching.

Hines et al<sup>8</sup> reported on a series of 31 patients treated using Kirshner wire fixation of the medial epicondyle fracture. While they did not investigate return to play, they reported that 96% (23/24) of patients had good results with operative treatment (if patients with an entrapped fragment were excluded from analysis). They defined a good result as “subjectively painless, stable elbow with no

gross deformity . . . with no tenderness over the medial epicondyle, no ulnar nerve symptoms, cubitus valgus less than 10° and no more than 15% loss of motion compared with the normal elbow.”

Lee et al<sup>11</sup> did not report on return to play but stated that “all patients returned to their previous level of activity” and had good to excellent results based on the Elbow Assessment Score of the Japanese Orthopedic Association, with a mean score of 97 points for screw fixation and 96 for Kirshner wire fixation.

Of the 8 adolescent baseball pitchers with a medial epicondyle fracture studied by Osbahr et al,<sup>14</sup> 5 were treated nonoperatively, and all were able to return to play at a mean 7.6 months. While Osbahr et al<sup>14</sup> had a smaller sample size and treated patients operatively and nonoperatively, their patient population closely mirrors our overhead athlete population, with similar mean age and return-to-play time.

### Outcome Scores

The KJOC scoring system is a validated scoring system that has been proven to be highly sensitive in the detection of upper extremity dysfunction in overhead throwing athletes. Franz et al<sup>7</sup> showed in a professional baseball organization significant differences in KJOC scores among healthy pain-free players (mean, 97), athletes playing with arm pain (76), and athletes not playing because of arm pain (65). Kraeutler et al<sup>9</sup> believed that the KJOC scoring system is an accurate assessment for overhead athletes and that “normal values should be greater than 90.” Our results demonstrated a mean KJOC score of 93, which is above the minimum threshold of 90 and significantly higher than the mean of 75 reported by Franz et al for players who had undergone upper extremity surgery.

The ASES-E was developed by the society of the American Shoulder and Elbow Surgeons to help with standardization of outcome measure after shoulder or elbow surgery. It consists of a questionnaire involving activities of daily living and patient self-evaluation. Michener et al<sup>12</sup> found that the ASES-E is a reliable, valid, and responsive outcome tool. Our case series demonstrated low self-reported pain, full function, and complete satisfaction. Unfortunately, previous studies of medial epicondyle fractures treated in an overhead athlete population did not utilize the ASES-E scoring system; therefore, direct comparison of patient outcomes is not possible.

### Fracture Union Rates

Our fracture union rate was 96% (22/23). Imaging for the 1 patient with delayed union was taken 3 months after ORIF, and it is unknown if he eventually had union of his fracture. The true union rate is difficult to determine, as final follow-up films were not available for every patient in the study. Our sports medicine and orthopaedic center serves as a subspecialty referral center for athletes, and many patients traveled a significant distance for surgery. As a result, many patients and their families preferred to follow up with a surgeon close to home, which affected the

availability of radiographic data for this study. This fracture union rate of 96% was slightly lower than previously reported rates, but our mean age of 14.7 years at the time of surgery was slightly higher. Case and Hennrikus<sup>3</sup> showed a 100% union rate at a mean of 6 weeks; however, their patient population was significantly younger than ours, with a mean age of 11 years. Hines et al<sup>8</sup> reported a 97% union rate, with their 1 nonunion occurring after open and percutaneous fixation with Kirshner wires; the mean age in this series was 12.7 years. Lee et al<sup>11</sup> reported a 100% radiographic union rate in patients with a mean age of 13.7 years. Union was achieved at a mean of 7 weeks after surgery. Osbahr et al<sup>14</sup> reported a 100% union rate and a mean patient age of 13 years. The case series of Lawrence et al<sup>10</sup> demonstrated a bony union rate of 100% among the 20 patients with medial epicondyle fracture: 14 treated using ORIF and 6 treated without surgery. The mean age of their patients undergoing surgery was 12.8 years.

### Complications

Case and Hennrikus<sup>3</sup> reported no surgical complications, and 25% (2/8) of their patients elected to undergo screw removal, although they had no hardware complications at the time. Hines et al<sup>8</sup> reported continued valgus instability and ulnar neuritis in the patient who developed a nonunion of her medial epicondyle. They also reported that 11% (2/19) of patients examined had notable valgus deformities. Two patients in this series had minor superficial pin infections that resolved after pin removal, local wound care, and use of oral antibiotics.

Lee et al<sup>11</sup> reported no surgical complications, infections, or neurological injuries in their series of patients with medial epicondyle fractures treated using surgical fixation. One patient demonstrated loss of motion, and another had mild valgus instability. There were no reports of hardware complications; however, a substantial number of patients elected to undergo hardware removal, with 56% (14/25) having screw removal, 28% (7/25) pin removal, and 8% (2/25) tension band wire removal. While their mean age of 13.7 years is comparable with our series, their series differs in that 36% of medial epicondyle fractures were associated with a posterolateral elbow dislocation, which may indicate a higher-energy mechanism.

In the Osbahr et al<sup>14</sup> series of 8 baseball pitchers with medial epicondyle fractures, 3 underwent ORIF. These 3 players showed great outcomes, no valgus instability, full range of motion, and no deformity. One of the 3 players in the operative group underwent hardware removal in the off-season because of hardware complications.

Lawrence et al<sup>10</sup> reported no significant hardware complications, sensory nerve injuries, or growth disturbances in either the operative or nonoperative cohort. Half of each group required formal physical therapy, and 36% (5/14) of the ORIF group and 33% (2/6) of the nonoperative group had a perceived residual loss of range of motion. One patient underwent revision surgery with capsular release and hardware removal, and 43% (6/14) of the ORIF group reported occasional ulnar nerve symptoms (numbness) with prolonged elbow flexion/compression.

### Indications

Historically, indications for surgical fixation of medial epicondyle avulsion fractures has been debated.<sup>15</sup> Previously described indications include ulnar nerve injury/dysfunction, entrapment of the medial epicondyle fracture fragment in the elbow joint, valgus instability of the elbow, high-demand upper extremity function, and/or displacement of up to 10 mm.

Case and Hennrikus<sup>3</sup> first stated operative criteria of (1) fracture displacement >5 mm or incarceration of the fragment in the elbow joint, (2) instability demonstrated by a valgus stress radiograph during examination under anesthesia, and (3) a patient who "participated in organized athletics and required a stable elbow for his or her sport." Hines et al<sup>8</sup> reported on a series of 31 patients treated operatively with the criterion for surgical intervention of a medial epicondyle fracture with >2 mm of displacement. Lee et al<sup>11</sup> retrospectively reviewed a series of 25 patients with medial epicondyle fractures treated operatively. Their indication for surgery was fracture displacement >5 mm and instability with valgus stress test (clinically or radiographically) or "a patient who participated in organized athletics and required a stable elbow" for the sport. Osbahr et al<sup>14</sup> reported on a series of 8 skeletally immature baseball pitchers who had an acute fracture of the medial epicondyle while playing. They used the surgical indication of >5 mm of displacement as seen on radiographs. Of these 8 patients, 3 underwent ORIF, and the remaining 5 were treated nonoperatively. Displacement and injury mechanism were taken into consideration in the treatment algorithm of the Lawrence et al<sup>10</sup> study of competitive adolescent athletes with medial epicondyle fractures. Their operative criteria were primarily based on mechanism and favored patients who "suffered a traumatic or high-energy injury or those with elbow instability or laxity." Overhead athletes who had an acute medial epicondyle avulsion fracture were in the "low energy" group.

Our institution has a relatively low threshold for treating avulsion fracture of the medial epicondyle using ORIF. This is especially true in the adolescent overhead throwing athlete who presents with an avulsion injury. Our criterion is any visible displacement seen on radiographic evaluation. The experience of our attending surgeons has shown that radiographic evaluation generally underestimates the true displacement secondary to rotational and extension deformity of the fracture fragment seen at the time of surgery. This is supported by Edmonds<sup>5</sup> who used computed tomography scan imaging to evaluate "nondisplaced" medial epicondyle fractures on plain radiographs. In this study, he found "that fractures that are found to be minimally displaced or nondisplaced by radiographs may have more than 1 cm of anterior displacement, for which surgery is usually recommended."

### Strengths and Limitations

Strengths of the study include a relatively large cohort of adolescent overhead athletes (N = 29) who underwent standardized operative intervention at a single institution with

a mean follow-up of 4.8 years (range, 1.0-13.5 years). With regard to limitations, we recognize that there are inherent biases attributed to the retrospective nature of this study including recall bias, lack of a control group, and selection and observer bias. Other limitations of the retrospective study were the unavailability of objective outcome measures—specifically, range of motion, valgus laxity, and long-term radiographic follow-up for some patients. Finally, the study was limited to young male overhead athletes; therefore, the implications for patients of other ages, sex, or athletic activities are unknown. However, even with these limitations, the findings of the study were strong and convincing for young male overhead athletes.

## CONCLUSION

Patients in this study had high subjective outcome scores and returned to play with little to no problems. Our study confirmed that ORIF of medial epicondyle fractures can result in reliable, pain-free return to competitive sports in athletes with high demands of their elbow, specifically overhead throwing. While 1 patient underwent elective hardware removal at a later date, overall there were no major surgical complications reported. Data derived from this study should provide physicians with a better understanding of how to counsel patients and their parents considering undergoing ORIF for a displaced medial epicondyle fracture including their risks, outcomes, and expected return to play.

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