

# Double-Row Repair for Recalcitrant Medial Epicondylitis

Victor J. Wu,\* MD, Stephen Thon,\* MD, Zachary Finley,\* MD, Hunter Bohlen,\* BS, Zachary Schwartz,\* MD, Michael J. O'Brien,\* MD, and Felix H. Savoie III,\*<sup>†</sup> MD

*Investigation performed at Tulane University School of Medicine, New Orleans, Louisiana, USA*

**Background:** Various techniques have been described for surgical treatment of recalcitrant medial epicondylitis (ME). No single technique has yet to be proven the most effective.

**Purpose:** To evaluate the clinical outcomes of a double-row repair for ME.

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

**Methods:** A retrospective review was performed on 31 consecutive patients (33 elbows) treated surgically for ME with a minimum clinical follow-up of 2 years. All patients were initially managed nonoperatively with anti-inflammatories, steroid injections, topical creams, and physical therapy. Outcome measures at final follow-up included visual analog scale (VAS) scores (scale, 0-10), time to completely pain-free state, time to full range of motion (FROM), Mayo Elbow Performance Scores (MEPS), and Oxford Elbow Scores (OES). Patients were contacted by telephone to determine current functional outcomes, pain, activity, functional limitations, and MEPS/OES. Successful and unsuccessful outcomes were determined by the Nirschl grading system.

**Results:** The mean clinical and telephone follow-up periods were 2.3 and 3.6 years, respectively, and 31 of 33 (94%) elbows were found to have a successful outcome. The mean VAS improvement was 4.9 points, from 5.8 preoperatively to 0.9 postoperatively ( $P < .001$ ). The mean MEPS and OES at final follow-up were 95.1 and 45.3, respectively. The mean time to pain-free state and time to FROM were 87.4 and 96 days, respectively. Unlike prior studies, no difference in outcome was found between those with and without ulnar neuritis preoperatively ( $P = .67$ ).

**Conclusion:** A double-row repair is effective in decreasing pain and improving the overall function for recalcitrant ME. Uniquely, the presence of preoperative ulnar neuritis was associated with higher patient-reported preoperative pain scores but not with poor outcomes using this protocol.

**Keywords:** aging; athlete; elbow; golf; medial epicondylitis; golfer's elbow

<sup>†</sup>Address correspondence to Felix H. Savoie III, MD, Department of Orthopedic Surgery, Tulane University School of Medicine, 1430 Tulane Avenue, New Orleans, LA 70112, USA (email: fsavoie@tulane.edu).

\*Department of Orthopaedic Surgery, Tulane University School of Medicine, New Orleans, Louisiana, USA.

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Medial epicondylitis (ME), commonly referred to as “golfer’s elbow,” occurs because of a pathologic alteration of the musculotendinous origin of the flexor-pronator muscles (flexor-pronator origin, or FPO). It has been associated with certain occupations and sports, including manual labor, tennis, golf, and swimming.<sup>‡</sup> Similar to lateral epicondylitis, this condition presents in the fourth and fifth decades of life but with a much lower incidence, almost one-fourth, than that of lateral epicondylitis.<sup>17,25,31</sup> Although nonoperative management is often successful in both conditions, a greater proportion of ME patients require surgical intervention than do lateral epicondylitis patients (12% vs 4%, respectively).<sup>21</sup>

The cause is thought to be an accumulation of micro-trauma resulting in tendinosis and degeneration of the

<sup>‡</sup>References 3, 8-11, 13-16, 21, 22, 24, 28-30.

FPO,<sup>8,11</sup> most commonly affecting the tendons of the pronator teres and flexor carpi radialis.<sup>3</sup> Patients experience pain on the medial elbow that is exacerbated by resisted forearm pronation and wrist flexion. ME is also commonly associated with ulnar neuropathy or neuritis, which may be the cause of additional pain.<sup>10</sup>

According to the modified Gabel-Morrey classification for ME, patients were categorized according to the severity of their associated ulnar neuritis. Type I patients had no associated ulnar symptoms. Type II patients were characterized by the presence of clinical signs and symptoms of ulnar neuritis, an association reported in up to 60% of ME patients.<sup>10,13-15,22,24,29</sup> Traditionally, the presence of preoperative ulnar neuritis has been associated with worse surgical outcomes, leading to overall success rates as low as 63%.<sup>10,15</sup>

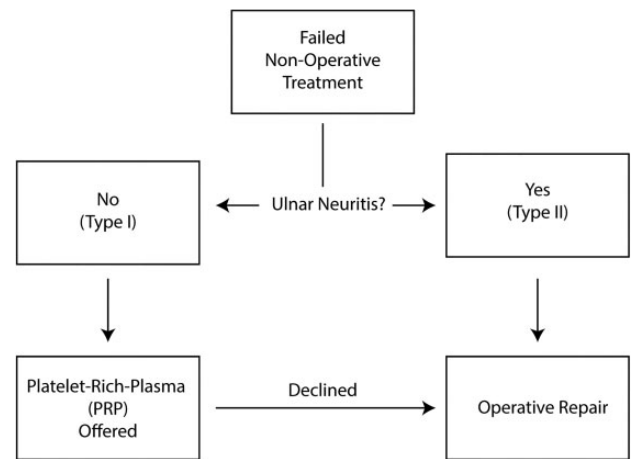
Nonoperative treatment is a mainstay in the initial management of ME, with symptoms resolving in up to 90% of cases.<sup>28</sup> Treatment in the conservative setting consists of activity modification, bracing, physical therapy, oral anti-inflammatories, and corticosteroid injections.<sup>1</sup> Recent series have reported the use of platelet-rich plasma (PRP) and stem cells.<sup>4,18,23</sup> In cases where symptoms prove refractory to conservative management for more than 6 months, operative treatment is indicated.<sup>22</sup> Published reports of operative intervention report successful outcomes in 63% to 97% of cases, with a wide range of surgical techniques described. Previously described techniques have included simple debridement of the tendon or medial epicondyle with<sup>5,14</sup> or without<sup>15,24,30</sup> microfracture, release of the tendon either open<sup>16</sup> or percutaneously,<sup>2,3</sup> or release and repair of the tendon via suture fixation<sup>10,22,28</sup> or suture anchor constructs.<sup>13,29</sup> Unique procedures have also been described with good results utilizing coblation therapy<sup>26</sup> in addition to a reported Z-lengthening procedure where a Z-shaped musculofascial lengthening is made in the FPO muscle-tendon origin.<sup>12</sup>

The procedure we use for refractory ME utilizes a T-split in the FPO with subperiosteal elevation of the FPO flaps. This is followed by a medial epicondylectomy and suture anchor repair of the tendon in a double-row fashion utilizing a “pants over vest” technique. This technique is applicable to all classes of ME, including those with ulnar neuritis. In this article, we present a retrospective review of our prospective case series using this technique.

## METHODS

### ME Treatment Protocol

All patients undergoing surgical treatment had an initial trial with nonoperative treatment. These conservative measures included injections with cortisone, oral anti-inflammatories (both nonsteroidal anti-inflammatory drugs and oral prednisone on different occasions), topical anti-inflammatory creams often compounded with additional medications to alleviate symptoms, bracing of the wrist in a neutral position, and targeted physical therapy that included iontophoresis and electrical stimulation.



**Figure 1.** Treatment protocol flowchart used to determine operative patients at our facility.

If the initial nonoperative protocol failed, we reexamined the patient for the presence of ulnar neuritis. If no signs or symptoms of ulnar neuritis were present, then a series of 2 ultrasound-guided leukocyte-rich PRP injections were given to the patient. The presence of severe ulnar neuritis in our practice precluded patients from receiving PRP injections that were unlikely to resolve any neuropathy symptoms.

If the PRP injection was declined or unavailable, patients were given the option to continue nonoperative management or consider operative intervention. An in situ complete ulnar nerve release from the medial intermuscular septum to the heads of the flexor carpi ulnaris was added to the surgical plan if preoperative ulnar neuritis persisted despite nonoperative measures. A preoperative, completely subluxating ulnar nerve was the only absolute indication to perform a subcutaneous transposition after intraoperative ulnar nerve release at our facility. Any patient requiring additional treatment for conditions other than ME and associated ulnar neuropathy was eliminated from consideration in this study. Figure 1 summarizes the protocol utilized at our facility.

### Study Participants

After institutional review board approval was obtained, a retrospective review of the 31 consecutive patients (33 elbows) who had failed conservative treatment (of an initial patient cohort of 96 patients) was conducted. All patients underwent surgical repair for ME between 2006 and 2015 and were identified using Current Procedural Terminology as well as International Classification of Diseases, Ninth Revision and Tenth Revision codes. All patients over the age of 18 years with isolated ME, with or without concurrent ulnar neuritis, were included. Exclusion criteria were clinical follow-up less than 2 years and/or confounding pathology in the ipsilateral upper extremity (eg, medial ulnar collateral ligament [MUCL] tear, rotator cuff pathology, and wrist pain). Any patient requiring additional treatment for conditions other than ME and associated



**Figure 2.** Patient in prone position for medial epicondylitis repair to allow for elbow arthroscopy. Arm is extended over an arm board with a bump under the elbow to elevate and stabilize the operative field (left). Incision begins 2 cm proximal to the medial epicondyle and extends 3 to 4 cm distally (right). DE, distal extension; PE, proximal extension.

ulnar neuropathy was eliminated from consideration in this study. A total of 31 patients met the final inclusion criteria and were included in this review. Of the 31 patients, 2 underwent bilateral repair for a total of 33 elbows.

### Preoperative Evaluation

Magnetic resonance imaging was obtained for all patients before operative fixation to assess the severity of disease and for confounding pathology. Preoperative pain levels were measured using a visual analog scale (VAS; scale, 0-10). Patients were evaluated for signs and symptoms of ulnar neuritis and classified according to the modified Gabel-Morrey classification.<sup>9</sup> Type I patients had no associated ulnar nerve symptoms, type IIA patients had only subjective ulnar neuritis without objective findings, and type IIB patients had positive objective findings, including a positive Tinel sign, positive elbow flexion test, tingling sensation in the ulnar distribution, muscle atrophy or weakness, or an actively subluxating ulnar nerve. Preoperative electromyography studies and nerve conduction velocity tests were not conducted.

### Operative Technique

Two senior authors (M.J.O. and F.H.S.) performed all procedures. Patients were placed under general anesthesia with an interscalene block for additional analgesia. All procedures were performed in the prone position. Elbow arthroscopy was performed in all cases to further rule out MUCL and capsular or intra-articular pathology. The shoulder was then internally rotated, allowing us to place the hand on a simple arm board, with the elbow flexed to 70° exposing the medial side of the elbow for the incision. As shown in Figure 2, an incision was started 2 cm proximal to the medial elbow in line with the intermuscular septum

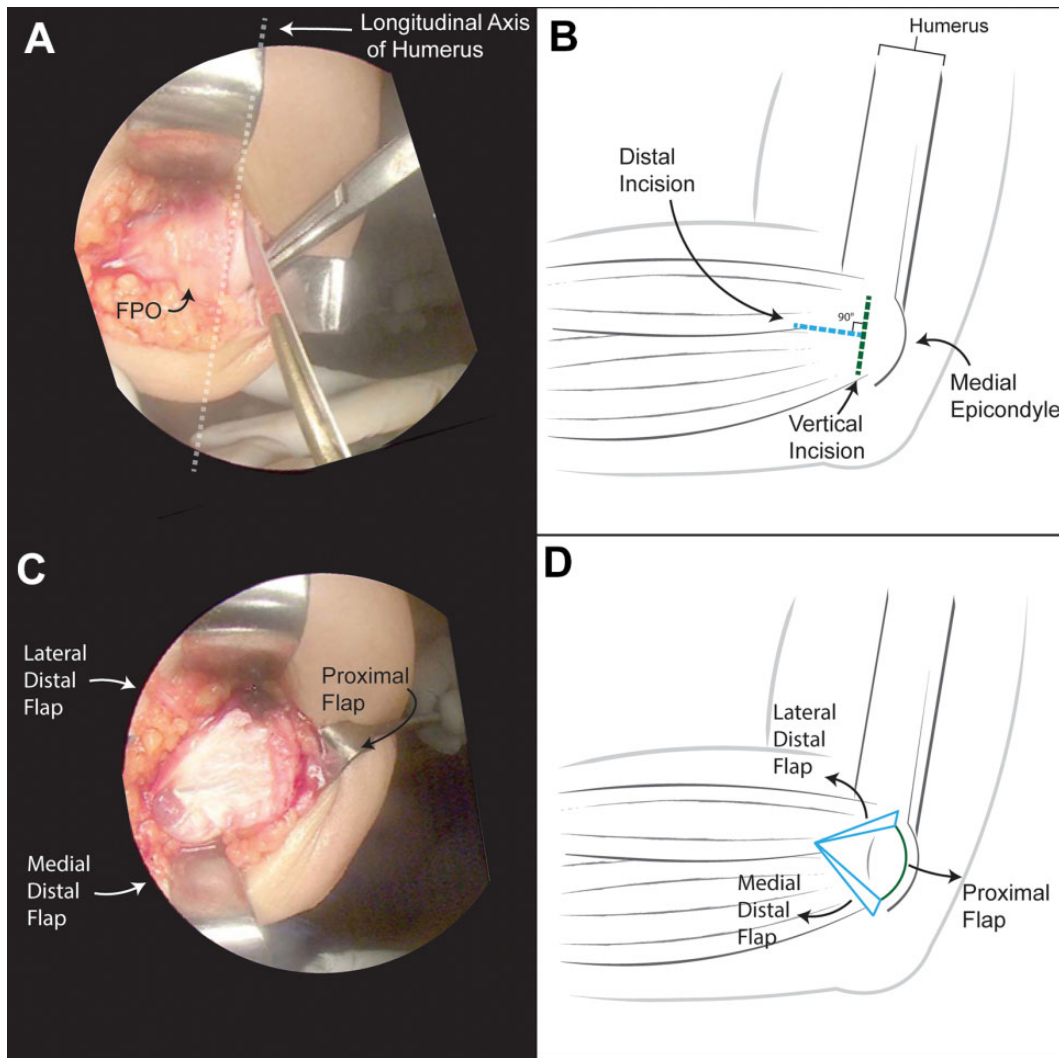
and then continued distally just anterior to the epicondyle and down the forearm for an additional 3 to 4 cm.

Initial skin flaps were created above the fascial plane to protect both the ulnar nerve and the medial antebrachial cutaneous nerve and its branches. The course of the ulnar nerve was explored, and the nerve was observed for any signs of compression. Neurolysis was performed at this stage if any signs of compression were found or if it was part of the surgical plan as previously described in the treatment protocol. If nerve transposition was indicated, because of a preoperative, completely subluxing ulnar nerve, it was performed at the end of the repair. Once the nerve was explored and protected using a vessel loop, the fascia of the FPO was exposed, along with the entire medial epicondyle.

After exposure of the flexor-pronator fascia, intermuscular septum, and ulnar nerve, a T-incision was made in the tendon. The initial incision in the tendon was vertical to the center of the tip of the epicondyle in line with the long axis of the humerus (Figure 3A). The second part was directly perpendicular to the center of the vertical incision and split the flexor-pronator fasci in line with its fibers (Figure 3B). The posterior aspect of the vertical incision on the epicondyle was subperiosteally elevated while carefully protecting the ulnar nerve to create a proximal flap for later repair. Distally, the lateral and medial FPOs were also elevated to expose the anterior aspect of the medial epicondyle, allowing inspection of the entire tendon (Figure 3, C and D).

The MUCL at the base of the dissection was identified and inspected. A small part of the tip of the medial epicondyle (3-5 mm) was then resected using either a small bone chisel or a rongeur. The exposed tip and anterior surface of the medial epicondyle was microfractured and then rasped to smoothen the surface (Figure 4A).

The flexor-pronator tendon was then inspected, and all pathologic tissues were subsequently debrided and removed. A single 1.9-mm double-loaded, all-suture anchor (Suture Fix Ultra; Smith & Nephew) was then



**Figure 3.** (A and B) T-incision in flexor-pronator origin (FPO) begins with a vertical line in line with the humerus. (C and D) Subperiosteal flaps are developed underneath to release the FPO from the medial epicondyle.

placed in the anterior aspect of the medial epicondyle with cortical bone still in place, just medial to the attachment of the MUCL and anterior to the rasped medial epicondyle (Figure 4B).

These sutures were used to repair the flaps of the distal medial conjoint tendon to the anchor in the deep part of the epicondyle by tying down the medial and lateral flaps in a mattress fashion (Figure 5, A and B). This first row of fixation repaired the second part of the T-incision side to side and created a nice flap that was repaired under the previously created proximal flap in a “pants over vest” fashion. The proximal flap, or “pants,” was pulled over the distal flap, or “vest,” covering the first mattress stitch (Figure 5, C and D). The edge of this proximal flap, created by the initial vertical incision, was then repaired with a running absorbable suture, creating the second row of the repair (Figure 6).

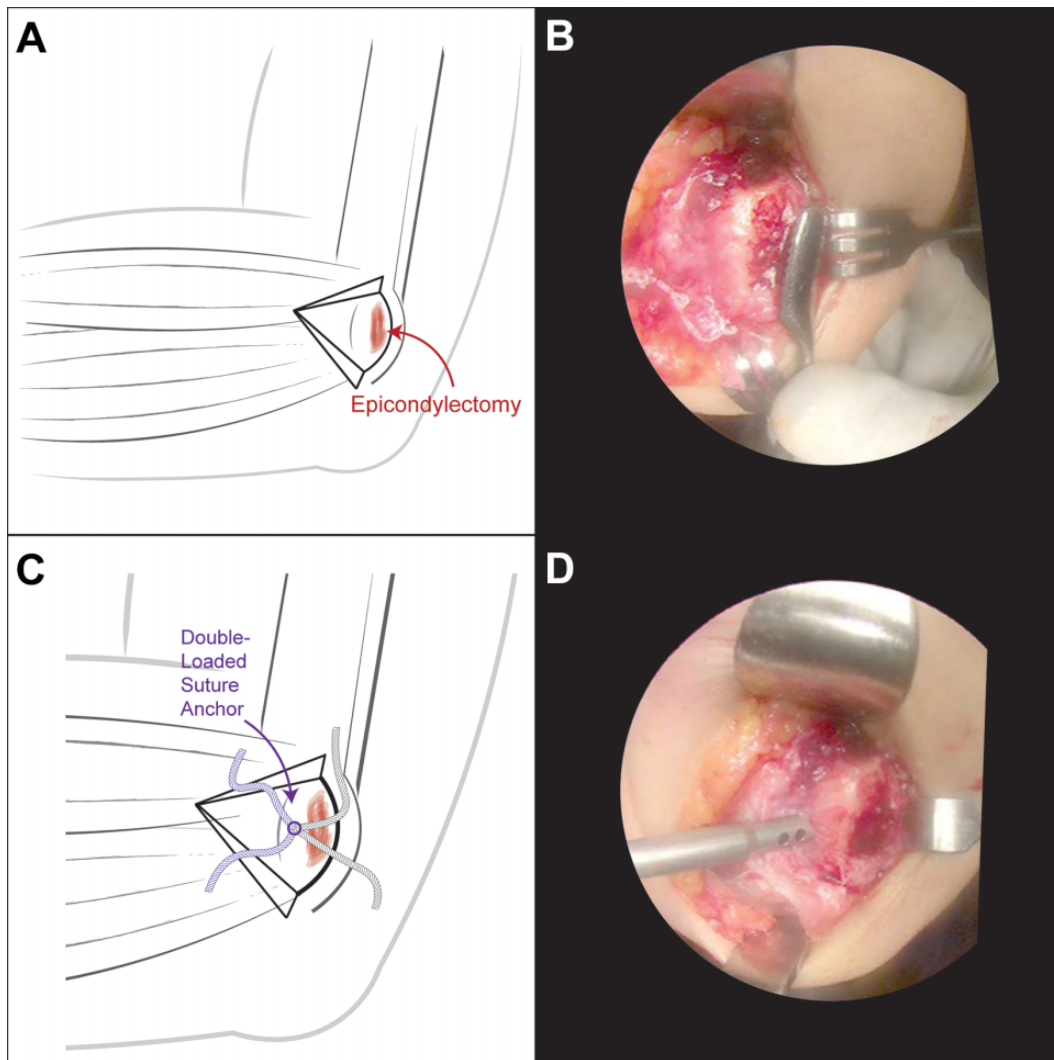
If ulnar nerve transposition was indicated, it was performed at this stage of the procedure. The elbow was then taken through a gentle full range of motion (FROM) arc

with the repair in place to observe the stability of the ulnar nerve and integrity of the repair. The wounds were then copiously irrigated, and the skin flaps were closed in a dual-layer closure.

### Postoperative Course

Postoperatively, the elbow was placed into a posterior slab splint for 1 week. After splint removal, dual bracing with separate elbow and wrist braces was applied for 6 weeks, and the patient was started on pain-free active range of motion (ROM) in the braces. The wrist brace was applied in neutral position to restrict active flexion. The elbow brace limited tension on the repair by first restricting active motion to 30° to 90° initially and then allowing increases in motion as pain and swelling decreased, with full motion obtained by 4 to 6 weeks. At approximately 3 to 4 weeks postoperatively, patients were permitted to start pain-free wrist and elbow





**Figure 4.** (A) Medial epicondylectomy is performed followed by (B) rasping to smoothen out the epicondyle. (C and D) A double-loaded suture anchor is centered anterior to the site of the epicondylectomy.

exercises. At week 8, patients began a strengthening protocol until pain-free status and FROM were achieved.

#### Follow-Up and Outcome Measures

Patients were seen at 1, 3, 6, and 12 weeks postoperatively. Thereafter, patients were seen at the surgeon's discretion for a minimum of 2 years. An ultrasound of the affected elbow was performed at the 6- to 8-week visit to assess for tendon healing at no cost to the patient (Figure 7).

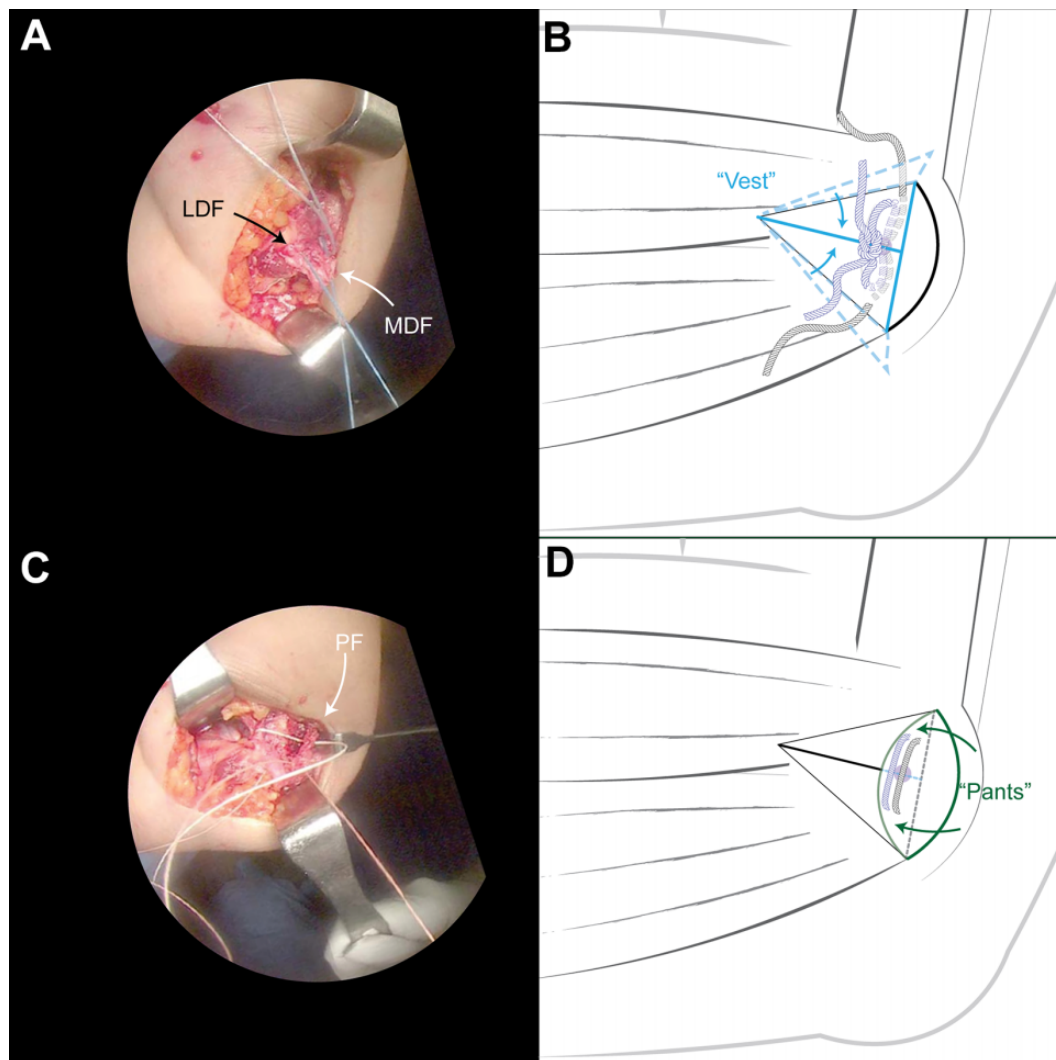
Pain status and ROM were recorded at each visit. Postoperative pain levels were determined using the VAS, and the difference in pain levels from preoperative scores was calculated at the final follow-up. Time to FROM, time to pain-free status, and return to work/return to activity (RTW/RTA) were also recorded. Only when patients were released to full activity was the status defined as RTW/RTA.

Study participants meeting the inclusion criteria were contacted via telephone to obtain postoperative pain levels,

activity levels, and patient-reported functional outcome measures consisting of the Mayo Elbow Performance Scores (MEPS, <0-100) and Oxford Elbow Scores (OES, 0-48). Each patient was also classified according to the Nirschl grading scale to determine the success or failure of treatment.<sup>20</sup> An outcome was considered excellent when patients achieved full activity with no pain, good when patients returned to full activity with only occasional mild pain, and fair when patients had pain with strenuous or heavy activity or were unable to return to their previous activity level. Failure was indicated when the operative intervention provided no pain relief. As per the original scoring system, an outcome was considered "successful" if the patient received a good or excellent rating.<sup>20</sup>

#### Data Analysis

Analysis was performed with SPSS Statistics for MacOS (Version 25.0; IBM). The Student *t* test was



**Figure 5.** (A) The first set of sutures (blue) is passed through the lateral distal flap (LDF) and medial distal flap (MDF) and tied in a mattress fashion to repair the distal flaps side to side. (B) This repairs the distal flexor-pronator origin to the deep part of the epicondyle and forms the “vest” in our final repair. (C and D) The unused set of sutures (white) is also passed through the distal flaps and tied in a mattress fashion to reinforce this first row of fixation. The proximal or posterior flap (PF) is then brought over the distal flap in a pants over vest fashion, preventing irritation from the underlying knots.

used to calculate the difference in means for parametric data. The Mann-Whitney *U* test and chi-square analysis were used for nonparametric and categorical data, respectively. Univariate analysis was used to calculate the odds ratios.

## RESULTS

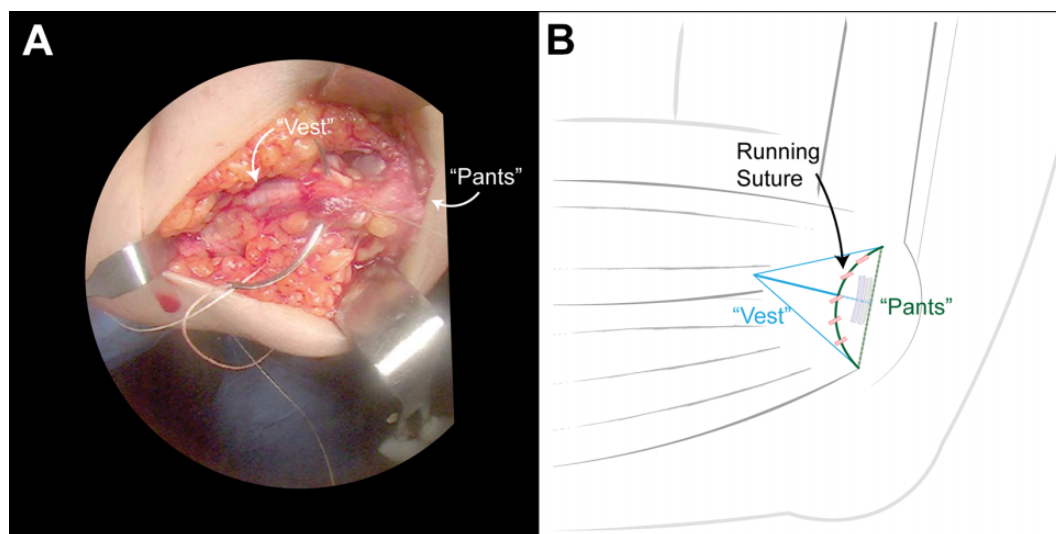
### Patient Characteristics and Clinical Characteristics

The mean age at the time of surgery was  $46.9 \pm 12.3$  years (range, 18-69 years). Approximately 61% (20/33) of elbows belonged to male patients. Patients underwent, on average, 4.3 months (range, 1.5-25.9 months) of non-operative management. The mean clinical follow-up was 2.3 years, with a mean follow-up of 3.6 years at the time

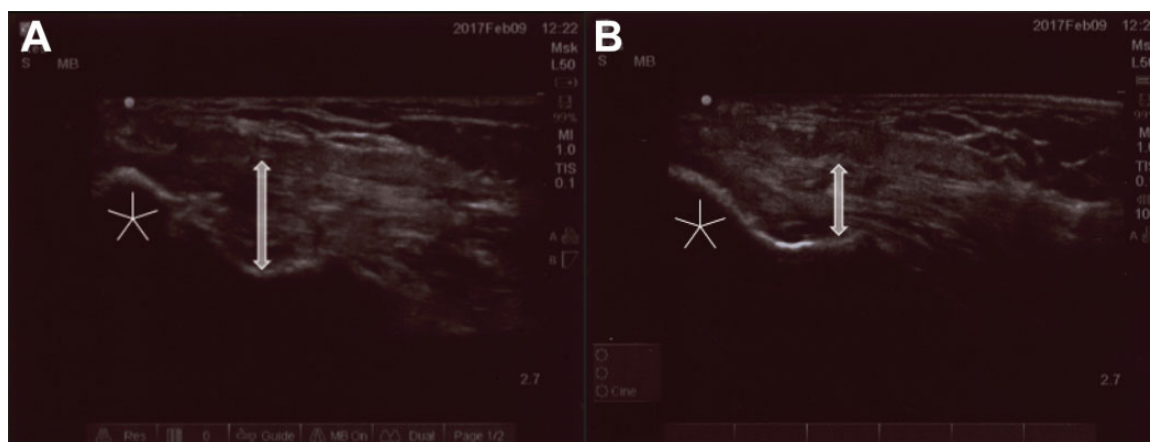
of telephone interview. According to clinical criteria, 18 elbows were classified as having type I ME and 15 elbows were classified as having type II ME. Therefore, the incidence of preoperative ulnar neuritis in this series was 45% (15/33). Type II elbows were further subclassified into type IIA (7 patients) and type IIB (8 patients) depending on whether they had subjective and/or objective ulnar neuritis symptoms. The characteristic data and clinical characteristics of operative patients are summarized in Table 1.

### Outcomes

The mean change in pre- to postoperative VAS scores was 4.9 points among the entire operative group. The mean time to FROM overall was 87.5 days (range, 24-226 days).



**Figure 6.** (A) A separate absorbable suture is used to tie the edge of the proximal flap or “pants” over the distal flap or “vest” in a running fashion. (B) This provided a second row of fixation, with the additional benefit of keeping the nonabsorbable suture knots buried under the proximal flap.



**Figure 7.** Ultrasound of the intact repair at 6-week follow-up at the (A) anterior and (B) posterior aspect of the anterior medial epicondyle. Striations from tendon are noted to be flowing into and inserting on the medial epicondyle. Star, medial epicondyle; double-sided arrow, full thickness of repaired tendon.

**TABLE 1**  
Characteristic Data and Clinical Characteristics<sup>a</sup>

Mean age (range), y	46.9 (18-69)
Sex	
Male	20/33 (61)
Gabel/Morrey classification	
Type I	18/33 (55)
Type II (preoperative ulnar neuritis)	15/33 (45)
Type IIA	7/33 (21)
Type IIB	8/33 (24)
Mean duration of symptoms prior, mo	4.3
Mean clinical follow-up, y	2.3
Mean follow-up at telephone interview, y	3.6

<sup>a</sup>Values are expressed as n (%) unless otherwise indicated.

The mean time to complete pain-free motion was 114.1 days (range, 6-308 days). The mean MEPS and OES at the final telephone follow-up were 95.1 (range, 65-100) and 45.3 (range, 25-48), respectively. The overall success rate, defined as good or excellent outcomes as per the Nirschl scale, was 94% (31/33). As shown in Table 2, 94% (17/18) of type I elbows and 93% (14/15) of type II elbows were considered to have a successful outcome.

Of the 2 unsuccessful outcomes, defined as fair and fail ratings on the Nirschl scale, 1 came from the type I group and the other from the type II group. Both patients received a fair rating, as they experienced pain relief but continued to have pain with heavier activity. The patient with the type I elbow that failed had residual pain and was unable to RTW in his previous capacity as a manual laborer. The

TABLE 2

Nirschl Grading System and Results in Operative Patients<sup>a</sup>

Nirschl Grading Scale		Overall	Type I	Type II
Excellent	Full return to all activity with no pain	16/33 (48)	9/18 (50)	7/15 (47)
Good	Full return to all activity with occasional mild pain	15/33 (45)	8/18 (44)	7/15 (47)
Fair	Normal activity with no pain, significant pain with heavy activity	1/33 (3)	1/18 (6)	1/15 (6)
Fail	No relief of preoperative symptoms	0/33 (0)	0/18 (0)	0/15 (0)

<sup>a</sup>Values are expressed as n (%).

patient with the type II elbow that failed was unable to achieve FROM at the final follow-up because of a slight loss of full extension secondary to pain, which limited her activity.

Preoperative ulnar neuritis was found in 15 of 33 elbows (45%) and had a higher association (odds ratio, 7.0) with preoperative pain rated as moderate to severe (VAS, 6-10). Of the 15 elbows, 7 were classified as type IIA ME and 8 were classified as type IIB ME. Of the 15 type II elbows, 10 underwent ulnar release and 5 underwent ulnar nerve transposition. Additionally, 2 elbows with type I ME underwent an ulnar nerve release because of the condition of the nerve found intraoperatively at the treating surgeons' (M.J.O. and F.H.S.) discretion. No difference in outcome was found between patients undergoing release versus transposition ( $P = .49$ ). The previously described patient who was unable to achieve full extension without pain at the final follow-up comprised the lone failure in the type II group and subsequently underwent neurolysis. However, the patient had full resolution of her ulnar nerve symptoms at follow-up.

As shown in Table 3, there was no difference in most outcome measures when comparing operative treatment in type I and type II elbows. There was no statistically significant difference in time to FROM, time to being in a pain-free state, or final MEPS. There was a statistically significant difference in the final OES in favor of type II patients; however, both groups scored in the excellent range. RTW/RTA was achieved in 97% (32/33) of elbows. As described earlier, only 1 patient was unable to RTW at his previous position, although he remained with his company in a different capacity.

### Complications

Other than the 2 unsuccessful outcomes, 1 minor complication was reported. A single patient had continued swelling at the 6-week follow-up mark that required adjustment of his physical therapy regimen. By his 3-month visit, the swelling had resolved after cessation of his physical therapy for 2 weeks.

### DISCUSSION

ME is a fibroblastic response to microtrauma from a combination of intrinsic contraction and valgus tensile stresses across the medial elbow.<sup>8,27</sup> Operative techniques, therefore, involve resecting the pathologic tissue,<sup>6</sup> releasing the FPO to reduce tensile forces,<sup>3,15</sup> or denervating the epicondyle.<sup>30</sup> The combination of our surgical technique involving a T-incision to create FPO flaps, a medial epicondylectomy, and suture anchor repair and protocol for addressing ulnar nerve symptoms provided successful results in the treatment of recalcitrant ME in 94% (31/33) of elbows, with reliable outcomes demonstrating improvement of pain, overall function, and ability to RTW/RTA. The results of our technique also appear to be lasting, with mean outcome scores for the MEPS and OES found to be in the excellent range at greater than 3-year follow-up.

Causes of failure after surgical treatment of refractory ME are similar to that of lateral epicondylitis,<sup>19</sup> including inadequate release,<sup>3</sup> missed or concomitant capsular or ligamentous insufficiency,<sup>22</sup> and continued neuritis.<sup>15</sup> The benefit of this open T-incision technique is that it allows adequate visualization for complete debridement of degenerative tissue. We performed arthroscopy on all patients, which assisted in identifying patients with additional capsular, ligamentous, or intra-articular pathology. This was found in approximately 25% of patients who were subsequently excluded from the study.

Our technique utilizes a suture anchor repair to restore the FPO and allow for full-strength recovery. Similar to our study, the 2 case series<sup>13,29</sup> that incorporated a suture anchor repair reported no influence of ulnar neuritis on surgical outcomes, which has historically been a negative prognostic factor.<sup>15,19</sup> A disadvantage of transosseous fixation is continued irritation of the ulnar nerve and the surrounding structures, which may have been a cause of the negative association of ulnar neuritis in the study by Gabel and Morrey.<sup>10</sup> Grawe et al<sup>13</sup> found success using 1 or 2 double-loaded anchors depending on the size of the medial epicondyle, but we found adequate fixation with a single anchor in all patients. Vinod and Ross<sup>29</sup> exchanged the permanent sutures for absorbable ones in their technique to further minimize irritation from the sutures. Our technique utilizes a "pants over vest" method as a second row of fixation to achieve the same goal, covering the nonabsorbable deep sutures with a flap.

The decision to release or reattach the tendon is controversial, with case series using both techniques having successful results. Vinod and Ross<sup>29</sup> documented their observations that patients with less secure reattachment had clinically measurable pronator weakness compared with suture anchor repair; however, weakness was not found in other studies<sup>16,24</sup> that incorporated partial resections without reattachment. Ollivierre et al<sup>22</sup> reported that their experience of complete tendon release led to greater valgus instability at the elbow; however, this was not found in a study by Han et al,<sup>14</sup> who reported on a series of patients who received a complete FPO release and had greater than 5-year follow-up. A possible reason for this discrepancy is that the study by Ollivierre et al contained far



TABLE 3  
Comparison of Operative Results Overall and for Type I Versus Type II<sup>a</sup>

	Overall	Type I	Type II	P Value
Patients, n	33	18	15	
Age (range), y	46.9 (18-39)	47.1 (18-62)	46.8 (23-69)	.65
Time to FROM, d	87.5	108.0	91.9	.39
Time to pain-free state, d	114.1	109.8	80.4	.052
VAS (0-10)				
Preoperative	5.8	4.6	6.8	.008 <sup>b</sup>
Postoperative	0.9	0.4	1.25	.11
Change	4.9	4.2	5.6	.06
MEPS (maximum 100)	95.1	95.6	97.5	.18
OES (maximum 48)	45.3	44.0	46.7	.04
Good or excellent Nirschl grade, n (%)	31/33 (94)	17/18 (94)	14/15 (93)	.67

<sup>a</sup>Bold indicated statistical significance. FROM, full range of motion; MEPS, Mayo Elbow Performance Scores; OEPS, Oxford Elbow Scores; VAS, visual analog scale.

<sup>b</sup>Ulnar neuritis (odds ratio, 7.0) had an increased likelihood of rating preoperative pain as moderate to severe (6-10).

more athletes, among whom at least 1 had competed at an elite level.<sup>22</sup> Because of the diversity of patients at our institution, we believe that reattachment in a standardized treatment protocol would provide optimal outcomes for all patients. While some proponents for release or resection without reattachment may be concerned over the longer time needed to protect the repair site,<sup>16</sup> our study demonstrated excellent outcomes in 94% of our patients and recovery of FROM in 97% of patients.

Medial epicondylectomy provided 2 potential benefits. First, the reduction of the footprint size decreased the pressure on the surgical site and tension on our repaired tendon. Second, it may have aided in our treatment of ulnar neuritis. Han et al<sup>14</sup> were able to demonstrate equivalent success in treating patients with and without ulnar neuritis with a technique that incorporated a medial epicondylectomy. Traditionally, medial epicondylectomy was recommended only in the presence of abnormal nerve conduct studies (NCS).<sup>7</sup> However, we did not perform NCS, as ulnar neuritis is a clinical diagnosis when associated with ME,<sup>9</sup> and studies have shown that most NCSs are negative despite the severity of ulnar nerve symptoms in ME cases.<sup>15,24</sup>

Historically, preoperative ulnar neuritis was associated with poorer outcomes.<sup>10,15</sup> Gabel and Morrey<sup>10</sup> reported 93% (13/14) success rate in elbows with no ulnar neuropathy symptoms versus 40% (2/5) in elbows with moderate-to-severe ulnar neuropathy symptoms. Kurvers and Verhaar<sup>15</sup> reported that 69% (11/16) of elbows with isolated ME were symptom-free, while only 13% (3/24) of elbows that had concomitant ulnar neuritis were symptom-free. As discussed, more recent studies<sup>13,14,24,29</sup> have questioned the relationship between preoperative ulnar neuritis and poorer outcomes. Similarly, in our case series, we found no difference in outcomes when using our technique in elbows with (94% successful) or without (93% successful) ulnar neuritis. Interestingly, our findings may suggest that patients with ulnar neuritis may have better results with our technique. Patients with type II ME required less time to become pain-free and a greater pain improvement based on the VAS although

neither of these findings were statistically significant ( $P = .052$  and  $P = .06$ , respectively). A possible explanation for these improved outcomes was that patients with type II ME had worse preoperative pain and therefore felt a greater subjective improvement. This would also explain why our study found statistically significant higher scores on the OES ( $P = .04$ ), which has a substantial subjective component compared to the MEPS, in patients with type II ME.

Published studies have varied in treatment and outcomes with regard to preoperative ulnar neuritis. As such, no single protocol has been determined to adequately stratify which patients require treatment, neurolysis, or transposition if they present with preoperative ulnar neuritis. Han et al<sup>14</sup> performed routine neurolysis on all patients regardless of preoperative ulnar nerve status, excluding those patients who required transposition. They did not directly compare type I and type II elbows but had an overall 94% success rate with all elbows and improvement in all 15 patients who had a positive preoperative Tinel sign. Gong et al<sup>12</sup> reported an 84% success rate by performing routine transposition with their Z-lengthening procedure in 19 patients with ME and concomitant ulnar neuropathy. In contrast, Shahid et al<sup>24</sup> did not perform neurolysis on any patient and had resolution of symptoms in all 8 patients with ulnar neuropathy. These universal treatment protocols have the potential effect of some patients being under- or overtreated, depending on the severity of their disease.

Unique to our study, the presence of ulnar neuritis was associated with a 7 times higher likelihood of patients rating preoperative pain in the moderate-to-severe range according to the VAS (range, 6-10). To our knowledge, this is the first time this phenomenon has been reported in the literature and would suggest that a higher preoperative visual analog pain scale may be an objective way of increasing suspicion of ulnar nerve issues. This finding, more importantly, indicates that the presence of ulnar neuritis appears to be a significant pain generator when found concurrently with ME. Because of this, we feel that any preoperative signs and symptoms of ulnar neuropathy, subjective or objective, should be addressed with neurolysis at the time of surgery.

Our treatment protocol is in contrast with the findings of Gabel and Morrey<sup>10</sup> and Shahid et al.<sup>24</sup> They found that decompression is unnecessary in patients without positive nerve conduction studies or intraoperative findings that indicate focal compression. In Gabel and Morrey's series, patients had successful outcomes without decompression only if they had mild ulnar signs or symptoms.<sup>10</sup> This may indicate that further study is needed in stratifying patients with ulnar neuritis for treatment. Most case series, including that by Shahid et al,<sup>24</sup> classify patients according to the presence or absence of ulnar neuritis symptoms, which may be easier to standardize than the "mild" and "moderate/severe" classification used by Gabel and Morrey. Our data indicate that future investigation into the relationship between preoperative VAS and ulnar neuritis severity may provide a path to refining future treatment protocols.

There are several limitations to this case series. Because operative treatment for ME is rare, we were limited by a small sample size. However, the number of patients in our cohort was consistent with others found in the literature, with the largest sample size previously reported having only 60 patients.<sup>5,10,12-16,24,26,28-30</sup> As a retrospective study, the study design was also limited by inherent biases associated with uncontrolled trials. This was addressed by prospectively implementing a standardized treatment protocol for all patients. In addition, there is no gold standard for the treatment of recalcitrant ME. Therefore, we were limited to compare our results with those of previously published case series. These studies varied greatly with our study and each other in treatment strategies, techniques, outcome measures, and patient information. For example, although we had an examination at the 1-year follow-up, our final follow-up was made by telephone contact; thus, we did not have a physical examination at the final follow-up and were therefore limited to outcome measures that relied mostly on subjective data. We also did not have information on which patients received workers' compensation. Future works may benefit from direct comparisons between 2 different techniques to better define treatment strategies and the role of ulnar nerve treatment.

## CONCLUSION

Surgical management utilizing a double-row technique with a deep suture anchor and superficial "pants over vest" repair is effective in improving pain and overall function for recalcitrant ME. The presence of preoperative ulnar neuritis was associated with higher preoperative pain scores but did not adversely affect the outcome. Our findings demonstrate that preoperative ulnar neuritis no longer precludes successful outcomes and that this technique is applicable to patients under the entire spectrum of disease for ME. Therefore, all patients can expect significant relief and improvement of function, even when neuropathy is present.

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