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Am J Sports Med 2005 33: 1558

DOI: 10.1177/0363546505276758

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Treatment of Recalcitrant Lateral Epicondylitis With Suture Anchor Repair

Steven J. Thornton, MD, Jennifer R. Rogers, William D. Prickett, MD, Warren R. Dunn, MD, MPH, Answorth A. Allen, MD, and Jo A. Hannafin,* MD, PhD

From the Sports Medicine and Shoulder Service, Hospital for Special Surgery, Department of Orthopaedic Surgery, Weill Medical College of Cornell University, New York, New York

Background: Chronic lateral epicondylitis has been treated with various surgical procedures with varying and often less-than-satisfactory outcomes.

Hypothesis: The use of suture anchor repair of the extensor carpi radialis brevis to the lateral epicondyle in the treatment of chronic lateral epicondylitis will result in a more anatomical repair, with resultant improvements in strength, pain, and return to previous sport.

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

Methods: A total of 20 patients (22 elbows) were treated surgically and were observed for a minimum of 2 years. All patients had debridement of the degenerative tissue, followed by repair of the extensor carpi radialis brevis to the lateral epicondyle with a suture anchor. The average time to follow-up was 4.2 years (range, 2.2-9.5 years). All patients completed a Disabilities of the Arm, Shoulder, and Hand questionnaire to assess residual disability, and 16 patients underwent a physical examination. The objective evaluation included the assessment of range of motion, grip strength, and pinch strength. Pain was assessed preoperatively and postoperatively using a visual analog pain scale. Patients were also questioned with regard to a return to their previous level of activities.

Results: The grip and pinch strengths achieved for the operative extremity were 110% and 106%, respectively, of the nonoperative limb. The 16 patients who underwent a physical examination had achieved full range of motion, with 15 (94%) returning to their previous level of activity at an average time of 4.1 months. The mean preoperative pain score was 8.1 (range, 4.0-10.0), whereas the mean postoperative pain score was 0.41 (range, 0-1.5), indicating significant pain relief ($P < .001$). The Disabilities of the Arm, Shoulder, and Hand scores demonstrated only mild residual disability (mean, 6.6) at follow-up.

Conclusion: The use of a suture anchor to repair the extensor carpi radialis brevis to the epicondyle after debridement was a satisfactory procedure for recalcitrant lateral epicondylitis with regard to strength, return to previous activities, and pain relief.

Keywords: lateral epicondylitis; suture anchor; recalcitrant; Disabilities of the Arm, Shoulder, and Hand (DASH)

Chronic lateral epicondylitis, or tennis elbow, is a common musculoskeletal disorder. This entity was first described by Runge²² in the German literature in 1873 and by Morris¹⁵ in the English literature. The majority of patients with this condition improve with nonoperative measures, such as physical therapy, forearm bracing,⁸ and steroid injections.^{20,23} In addition, close to 80% of patients have been shown to improve over a period of 1 year of nonoperative treatment.^{5,9} In studies by Boyd and McLeod⁴ and Posch et al,¹⁹ 3% to 8% of patients required operative

intervention for resistant symptoms. Surgical options include percutaneous techniques,^{3,25} arthroscopic resection,^{2,13,18} epicondylar resection with anconeus transfer,¹ division of the deep fascia covering the common extensor group,¹⁹ distal lengthening of the extensor carpi radialis brevis (ECRB), and excision of the degenerative lesion of the ECRB.¹⁷ These studies have shown generally good results with surgical intervention, but the reports of pain relief have been inconsistent.

Histopathological examination of the lesion of the ECRB demonstrates a degenerative process without evidence of acute inflammatory cells in end-stage specimens.^{12,17} The characteristic appearance of this granulation-like tissue includes immature fibroblasts and disorganized, nonfunctional vascular elements and has been termed angiofibroblastic hyperplasia by Nirschl and Pettrone.¹⁷ It is theorized that epicondylitis results from an aborted healing response to microtrauma, combined with vascular depri-

*Address correspondence to Jo A. Hannafin, MD, PhD, 535 East 70th Street, New York, NY 10021 (e-mail: HannafinJ@hss.edu).

No potential conflict of interest declared.

vation at the tendon origin. The degree of angiofibroblastic infiltration appears to correlate with the clinical phases of pain and the duration of symptoms.¹⁶

Although the ECRB is intimately attached to the underside of the longus, it is thought that adequate debridement often necessitates elevation of the majority of the brevis muscle attachment from the epicondyle. In previous studies, either the granulomatous tissue was minimally debrided or the ECRB tendon was not reattached to the lateral epicondyle. The hypothesis of this study is that the debridement and firm reattachment of the ECRB to the lateral epicondyle will result in more consistent outcomes with regard to pain relief and return to previous level of sporting activity. By providing a bone-tendon interface at the repair site, we can more closely approximate the native anatomy and function of the extensor origin. To our knowledge, this article is the first report in the literature on the treatment of lateral epicondylitis with the use of a suture anchor.

MATERIALS AND METHODS

Repair of the ECRB tendon to the lateral epicondyle using a single suture anchor was performed in patients with chronic refractory lateral epicondylitis. Patients were offered surgical treatment if they had failed a minimum of 6 months of nonoperative treatment, including nonsteroidal anti-inflammatory medication, physical therapy, forearm braces, and/or single or multiple local injections of corticosteroid and anesthetic. Many patients had received prolonged nonoperative management at outside facilities before referral. All patients had well localized lateral elbow pain and tenderness over the lateral epicondyle that limited activities of daily living and sports. Preoperative magnetic resonance (MR) imaging of the affected elbow was obtained on all patients to rule out associated intra-articular abnormalities and to evaluate ECRB tendon integrity. These images were assessed for intratendinous signal change and morphologic alteration from the normal uniform hypointense signal and vertically oriented course of the extensor tendons to ascertain the severity of injury (Figure 1).

Between March 1994 and March 2001, 24 consecutive patients with a total of 26 affected elbows were treated for lateral epicondylitis with this technique by the senior author (J.A.H.) at the Hospital for Special Surgery. Sixteen patients completed the physical examination and Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire, whereas 4 patients were unable to return for a physical examination but completed the DASH questionnaires by mail. The remaining 4 patients who declined to participate in the study reported satisfaction with their surgical outcome with regard to pain relief and return to previous sporting activity. These patients did not participate in the study secondary to time constraints in their daily schedules. In all, 20 (83%) of the 24 patients elected to participate in the study, with a total of 22 affected elbows. The nondominant extremity was involved in 7 patients. There were 9 men and 11 women, with an average age of 47.3 years (range, 37-64.5 years). All patients



Figure 1. An MRI of a complete tear of the extensor carpi radialis brevis (ECRB) tendon.

reported pain with activity of the affected limb and debilitating functional impairment. The average time to follow-up period was 4.1 years (range, 2.2-9.5 years). The senior author performed all surgical procedures.

As previously stated, 16 of the 24 patients were available for a physical examination and completion of the DASH questionnaires. This group included the 2 patients who had bilateral procedures, resulting in the complete evaluation of 18 elbows. The objective evaluation included the assessment of range of motion, grip strength, pinch strength, pain, and instability. These patients were also questioned with regard to a return to previous level of activity, number of preoperative corticosteroid injections, and onset of symptoms, to confirm data present in the medical record. Tourniquet and surgical times were also reviewed.

A standard goniometer was used to evaluate range of motion. The preoperative range of motion at the elbow and wrist were well documented in the office record and were compared to the range of motion achieved at final follow-up. Forearm rotation was recorded as the degrees of pronation and supination from the neutral position. Grip strength was measured using a Jamar dynamometer (Jamar, Bolingbrook, Ill) and was recorded as a percentage

of the opposite limb. Similarly, pinch strength was measured using a B & L dynamometer (B & L Engineering, Tustin, Calif) and recorded as a percentage of the opposite limb. The 2 patients who had bilateral procedures were excluded from the dynamometer part of the study, as it was not possible to compare with a nonoperative extremity. A total of 14 elbows in 14 patients were available for strength measurements of grip and pinch strengths. The strengths of forearm supination and of wrist extension were graded from 0 to 5 using the standard manual muscle strength grading system. All 18 extremities were included in this strength grading.

The patient's sporting activity that was most limited by the lateral epicondylitis was identified. The postoperative ability to return to these activities at the preinjury level was ascertained at follow-up. Pain was evaluated preoperatively and postoperatively with a visual analog pain scale (VAS). This scale was graded from 0 (no pain) to 10 (severe pain). The patients were asked to mark the point they thought was the best representation of their overall pain level. A comparison between preoperative pain and postoperative pain was performed using a Wilcoxon signed rank test.

The outcome tool utilized was the DASH instrument. Of the 24 patients, 20 (83%) responded to the DASH questionnaire. The DASH questionnaire is an outcome instrument specific to the upper extremity and applicable to a wide variety of conditions. The questionnaire contains 30 items: 21 assessing difficulties with specific tasks, 5 regarding symptoms, and 1 each regarding social function, work function, sleep, and confidence. The score ranges from 0 (normal) to 100 (significant impairment of upper extremity function) points. Statistical analyses were performed using SAS 9.0 for Windows 9.0 (SAS Institute, Cary, NC), and significance was defined as $P < .05$.

Surgical Procedure

The procedure was performed on an outpatient basis with axillary block anesthesia. A linear incision approximately 2.5 cm in length was made extending from a point just proximal to the lateral epicondyle distally in the redundant skin just posterior to the epicondyle. The deep fascia overlying the common extensor tendon was incised longitudinally and retracted. The interval between the extensor carpi radialis longus (ECRL) and the aponeurosis of the extensor digitorum communis was incised. This interval was easily identified by the thin fascia overlying the muscle of the ECRL and the thicker fascia of the common extensor origin. A self-retaining retractor was used, and the origin of the ECRB was exposed. The ECRB was palpated and visually examined for gross alterations (Figure 2A). Yellow-gray amorphous granulation tissue was uniformly present at the ECRB, which was readily contrasted with the normal shiny, white tendon fibers. The granulation tissue was sharply excised and removed. Care was taken to dissect this tissue from the underlying capsule of the radiocapitellar joint without entering the joint. Excision of the lesion began distally from a point where normal tendon fibers could be seen and progressed proxi-

mally toward the lateral epicondyle. The lateral epicondyle was then gently curetted to remove any fibrous tissue and to provide a bleeding surface for extensor reattachment (Figure 2B). A recipient site was drilled into the lateral epicondyle for placement of the mini-Mitek suture anchor (Ethicon Inc, Piscataway, NJ). The anchor was secured in the drill hole, and the overlying origin of the ECRB and common extensor tendon was secured to bleeding cancellous bone using a simple suture (Figure 2C). A side-to-side repair of the extensor tendon was performed with a 2-0 absorbable suture (Figure 2D). The fascia and subcutaneous tissues were approximated with a 2-0 absorbable suture and the skin closed with a running 3-0 absorbable suture and Steri-Strips (3M, St Paul, Minn).

Postoperatively, the extremity was placed in a sling but was not immobilized. Gentle, active elbow range of motion was initiated on postoperative day 1. Patients were instructed to increase their active arc of motion daily, with a goal of full elbow extension at postoperative day 10. At 7 to 10 days' follow-up, the suture was removed and a cock-up splint was placed on the wrist to allow increased use of the extremity while protecting the tendon repair. Patients were allowed the active use of the elbow, including writing, computer use, and activities of daily living, but were instructed to refrain from lifting or carrying with the extremity. At 6 weeks postoperatively, the cock-up splint was discontinued for activities of daily living but was used for carrying or prolonged computer use. A 6-week course of supervised physical therapy that focused on strengthening wrist extension, flexion, pronation, and supination was initiated. Return to sports activities, such as tennis and golf, was permitted at 12 weeks postoperatively if full range of motion and strength had been achieved.

RESULTS

The mean time from the onset of symptoms to surgical intervention was 2.42 years (range, 0.5-7 years). Patients received an average of 1.4 corticosteroid injections (range, 0-4 injections) (Table 1). The mean tourniquet time was 23 minutes (range, 12-43 minutes), with a mean procedure time of 31 minutes (range, 21-48 minutes). All 20 patients underwent preoperative MR imaging of the affected elbow. The ECRB tendon demonstrated an abnormal shape and signal intensity at the insertion site onto the humerus in all patients. Based on focal tendon thinning and abnormal signal intensity, partial thickness tears were seen in 16 of 20 patients. Frank ruptures were noted in 4 of 20 patients. There were no tears noted in the adjacent radial collateral ligament.

Eighteen arms in 16 patients were examined. Full extension, flexion, pronation, and supination were documented in all 18 extremities when compared with the nonoperative limb. The average range of motion achieved for the operative limb was elbow flexion, 152° (range, 140°-170°); elbow extension, -1.9° (range, 0° to -10°); forearm pronation, 85° (range, 80°-90°); forearm supination, 85° (range, 60°-90°); wrist flexion, 77° (range, 60°-90°); and wrist extension, 74° (range, 20°-115°). In 5 of the 18 arms,

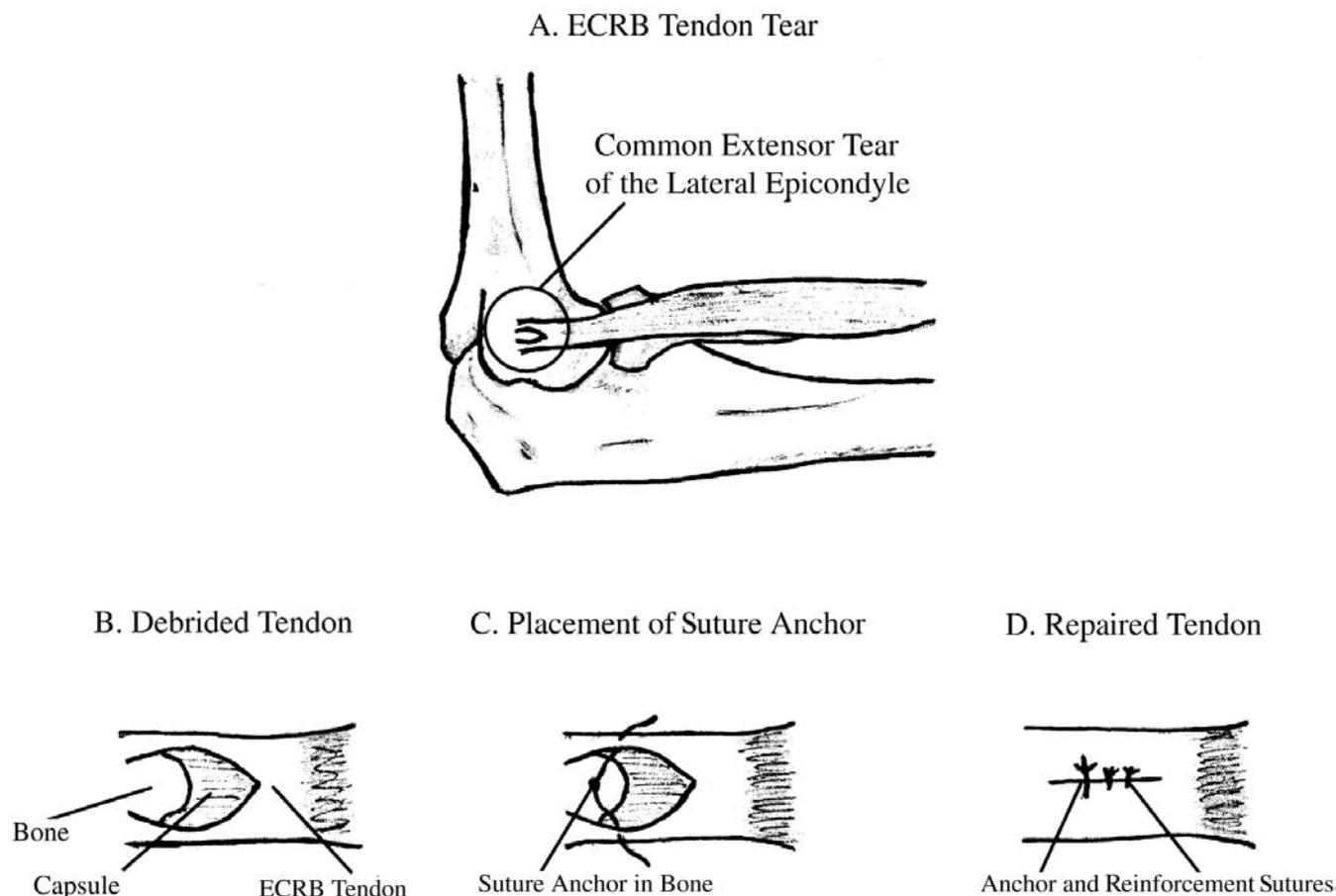


Figure 2. Repair of the extensor carpi radialis brevis (ECRB) tendon with a suture anchor. A, a tear of the ECRB tendon origin. Yellow-gray amorphous granulation tissue is usually present at the origin, indicative of repetitive trauma, which is readily contrasted with normal shiny, white tendon fibers. B, all granulation tissue is sharply excised and removed. Care is taken to remove this tissue from the underlying capsule of the radiocapitellar joint without entering the joint. C, the suture anchor is secured in the drill hole at the lateral epicondyle. A limb of the suture anchor is placed through each side of the tear. D, a side-to-side repair of the remaining extensor tendon is performed with a 2-0 Vicryl suture.

a flexion contracture was present before surgical intervention. The mean extension deficit at the time of surgery was 15° (range, 5° - 30°) for these 5 extremities. At follow-up, an elbow extension of -1° (range, 0° to -5°) was achieved in comparison to the nonoperative limb in these 5 extremities.

The grip strength was +110% of the nonoperative extremity, and the mean pinch strength was +106% of the nonoperative extremity. All 18 extremities demonstrated 5 of 5 strength of forearm supination strength. Sixteen of 18 (89%) extremities demonstrated full power with wrist extension. The 2 patients who demonstrated weakness with wrist extension were pain free and able to participate in sports at their previous level of activity (Table 2).

Of the 16 patients available for a physical examination, 94% ($n = 15$) were able to return to their preinjury activity status, which involved a range of activities that included tennis, golf, polo, skiing, rowing, bowling, and weight lifting (Table 1). The mean number of physical therapy sessions required to return to the preinjury level of sporting

activity was 14 sessions, with an average return to sporting activity at 4.1 months. One patient did not return to her previous activity level secondary to anxiety over the possibility of symptoms returning. At follow-up, this patient had a DASH score of 9.17, revealing minimal residual disability and a pain score of 1.5 out of 10.

All 16 patients reported disabling pain as the primary reason for seeking surgical intervention. The mean preoperative score on the VAS was 8.1 (range, 4-10). The mean score on the VAS at an average follow-up of 4.2 years was 0.41 (range, 0-1.5) (Table 2). This finding represented a 95% reduction in patient-reported pain scores at follow-up, which was statistically significant ($P < .001$), even in this small cohort.

Of the 24 patients, 20 (83%) responded to the upper extremity-specific health-status measure (the DASH questionnaire) on 22 extremities (Table 1). The mean DASH score of 5.9 (range, 0-45) for these 22 extremities demonstrated mild residual disability. Of these 20

TABLE 1
Demographics, Duration of Symptoms, and Postoperative Disabilities of the Arm, Shoulder, and Hand (DASH) Scores

Patient No.	Age, y	Affected Side	Duration of Symptoms, mo	Injections	Sports/Activity	Postoperative DASH
1	47	Right ^a	15	2	Biking	16.67
	48	Left	27	2	Biking	10
2	75	Right ^a	6	1	Tennis	9.17
3	42.5	Right ^a	6	0	Weights	0
4	37	Right ^a	14	4	Golf	0
5	47	Right ^a	4	0	Rowing	1.67
6	42	Left	9	3	Golf	2.5
7	44.5	Right ^a	2	0	Polo	0.83
8	44	Right ^a	18	4	Tennis	0
9	39	Left	6	1	Weights	0.86
10	56	Left	10	0	Weights	11.67
11	45	Right ^a	30	3	Tennis	7.5
12	64.5	Left	7	1	Skiing	2.5
13	43.5	Right ^a	2	0	Weights	0
	45	Left	1	0	Weights	0
14	51.5	Right ^a	84	2	Tennis	9.17
15	56	Right	13	4	Golf	0
16	57	Right ^a	240	0	Running	0.83
17	45	Right ^a	10	1	Tennis	8.33
18	30.5	Right ^a	8	2	Tennis	0
19	36.5	Right ^a	9	1	Weights	45.83
20	45	Left ^a	120	0	Bowling	1.67

^aDenotes dominant extremity.

TABLE 2
Postoperative Strength and Preoperative and Postoperative Visual Analog Pain Scores (VAS)

Patient No.	Affected Side	Strength of Nonoperative Extremity, %		Wrist Extension (0-5)	Preoperative VAS	Postoperative VAS
		Pinch	Grip			
1	Right ^a			5	10	1.3
	Left			5	10	1.3
2	Right ^a	83	125	5	8	0
3	Right ^a	100	100	5	6	0
4	Right ^a	107	105	5	9	4
5	Right ^a	114	116	5	9	0.25
6	Left	86	211	5	9	0
7	Right ^a	109	97	5	5	0
8	Right ^a	106	107	5	9	0
9	Left	107	92	5	8	1
10	Left	100	70	5	10	1.4
11	Right ^a	98	117	5	9	2
12	Left	125	81	5	5	0
13	Right ^a			5	9	0
	Left			5	9	0
14	Right ^a	80	89	4+	4	1.5
15	Right	160	133	5	9	0.85
16	Right ^a	95	103	4+	8	0

^aDenotes dominant extremity.

patients, 18 (90%) demonstrated a DASH score less than 10 (range, 0-9.17), with only 3 patients demonstrating scores above 10 (range, 11.67-45.83). The patient who scored a 45.83 on the DASH questionnaire was a workers' compensation patient.

DISCUSSION

Various procedures for the operative treatment of chronic lateral epicondylitis have been described in the literature.^{1-3,13,17,19,25} However, the results of these procedures

vary greatly with regard to consistent pain relief and outcome. The use of a suture anchor to directly attach the remaining ECRB to the epicondyle after debridement was a successful procedure for recalcitrant lateral epicondylitis in this study. The favorable results documented in this series appear to temper concerns regarding the consistency of operative treatment for chronic lateral epicondylitis.

Sporting activities were not limited after repair of the ECRB with a suture anchor. Ninety-four percent of patients were able to return to their preinjury sports participation, including tennis, golf, polo, rowing, bowling, and weight lifting, all activities considered high-stress sports with regard to exertion across the elbow. The 1 patient (patient no. 16) who did not return to her previous sport stated that she was simply anxious that symptoms might return, despite excellent postoperative DASH and VAS scores.

The average tourniquet and surgical times were 23 and 31 minutes, respectively. The time necessary for placement of a suture anchor was not thought to be excessive.

Questions regarding the potential loss of strength that occurs when the ECRB is not repaired to its origin on the lateral epicondyle had been raised previously. Almquist et al¹ demonstrated a 70% to 80% return of grip strength of the operated side in comparison with the nonoperated side with transfer of the anconeus. Khashaba used standard Nirschl techniques without drilling or decortication.¹¹ Average extension power did not reach the level of the unaffected elbow at 6 months in the majority of these patients. Similarly, at the Kerlan-Jobe Orthopaedic Clinic, 39 patients were evaluated after debridement and side-to-side repair of the ECRB. Of these 39 patients, 36% had limitations with heavy lifting, 50% had grip-dynamometer deficits, and 100% had some degree of isokinetic deficit.^{6,10}

The results in this study demonstrate excellent strength of the operative extremities in comparison to the nonoperative extremities. The grip and pinch strengths were 110% and 106%, respectively, when compared with the nonoperative limb. There was a concern that postoperative comparison of operative and nonoperative limbs might be biased secondary to the inherent strength of the dominant extremity. The mean grip and pinch strengths achieved for the nondominant operative extremities (n = 7) were 87% and 109%, respectively. In comparison, the mean grip and pinch strengths achieved in the dominant operative extremities (n = 9) were 120% and 105%, respectively. This finding equals or surpasses the 10% difference normally seen in adults relative to hand dominance.^{7,14}

Pain was the major symptom in all patients, and the relief of pain is the primary goal of treatment for tennis elbow. Published studies demonstrate that the majority of patients have excellent pain relief and are able to return to their previous level of sporting activity, regardless of the surgical technique. However, there are approximately 10% to 20% of patients who are unable to continue with their previous level of sports secondary to pain. In the classic article by Nirschl and Pettrone,¹⁷ 88 elbows in 82 patients were treated with excision of the identified lesion of the ECRB and simple repair. Of these 82 patients, 13 patients

(16%) were described as having a fair to poor result, with significant pain with heavy activity or no improvement in symptoms. More recently, Rosenberg and Henderson²¹ reported on 19 patients treated with excision and simple repair of the ECRB with a minimum of 2 years' follow-up. Six patients (21%) stopped or changed their sporting activity postoperatively secondary to continued symptoms. Similarly, Verhaar et al²⁴ observed 57 patients for a minimum of 5 years after excision of the lesion of the ECRB with concomitant simple repair, noting that 11% of patients had fair to poor results at 5-year follow-up.

We recognized that this study has several limitations inherent in the retrospective design and lack of a control group treated with a simple debridement. There was no documentation of preoperative strength of the forearm musculature with which to compare the postoperative strength. Thus, the strength of the operative extremity was assessed relative to the strength of the nonoperative extremity. There was no preoperative documentation of the DASH score for the operative extremity, and therefore no DASH score improvement could be statistically assessed. In addition, only 67% of patients (16 of 24) returned for the physical examination portion of the study.

We conclude that repair of the ECRB to a bleeding cancellous bed with the use of a suture anchor is a valid and reliable treatment option for recalcitrant lateral epicondylitis, with predictable pain relief and return to sporting activities in this cohort. The 95% reduction in the mean VAS from 8.1 (range, 4-10) to 0.41 (range, 0-1.5) was statistically significant ($P < .001$), and the mean DASH score was 6.6 at the time of follow-up, indicating that minimal residual disability was present in this patient population. This technique allowed for a more anatomical repair of the ECRB and may minimize the degradation of grip and pinch strengths noted after debridement of the ECRB. This article is the first in the English literature to describe the repair of the ECRB with suture anchors and to report the subsequent results. This descriptive study provides data to design future prospective studies comparing this technique with other established and novel techniques.

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