Late Surgical Results of Reattachment to Bone in Repair of Chronic Lateral Epicondylitis

Mark E. Pruzansky, MD, George D. Gantsoudes, MD, and Nathan Watters, BA

Abstract

All cases of lateral epicondylitis surgically treated in Dr. Pruzansky's office practice between October 1986 and December 2005 yielded 24 elbows for this study. Patients were treated with surgical débridement and direct repair to bone through bone tunnels (18 elbows), repair with suture anchors (3 elbows), or augmentation with autologous tendon graft and reattachment to bone via suture anchors (3 elbows).

This series represents the earliest reattachment cases to be reported, and with the longest follow-up. Mean follow-up (both telephone and office interviews) was 64.7 months. All patients reported satisfaction and graded their outcomes as good or excellent. Mean time to full painless preinjury level of use of the elbow was 4.3 months for patients who underwent simple repair and 2.75 months for patients repaired with a graft. Surgical reattachment of the débrided extensor tendon of origin of the elbow to bone, either directly or with autologous tendon graft, provided pain relief and return to preinjury level of function in a predictable manner.

Both primary repair and tendon graft procedures can be used in primary and salvage surgeries in tennis elbow cases in which conservative treatment fails.

Traumatic lateral epicondylitis, commonly referred to as *tennis elbow,* is caused by a partial or complete tear of the tendon of origin of the extensor carpi radialis brevis muscle, occasionally including the extensor carpi radialis longus and/or extensor digitorum communis.[1] Chronic lateral epicondylitis is the result of tendinous nonrepair for at least 6 months. For patients who have chronic lateral epicondylitis but are not receptive to conservative therapies,[1-32] surgery offers 80% to 95% success.

In this report on our retrospective clinical investigation, we describe 3 related techniques for suturing the common extensor tendon to bone to more closely approximate normal anatomy. Strength and proprioception in the forearm extensor muscles ought to be maximized through direct reattachment to the lateral epicondyle rather than through adjacent intact musculotendinous units. This concept, which has been in use for more than 20 years, produces a predictable return to previous sports and activity level. This series represents the earliest reattachment cases to be reported, and with the longest follow-up. One of the techniques is an alternative salvage procedure described for use in cases with severe tendon deficiency.

Dr. Pruzansky is Assistant Clinical Professor of Orthopaedic Surgery, and Dr. Gantsoudes is a Resident, Department of Orthopaedic Surgery, Mount Sinai School of Medicine, New York, New York.
Mr. Watters is a graduate of Washington University, St. Louis, Missouri.

Address correspondence to: Mark E. Pruzansky, MD, 975 Park Ave, New York, NY 10028 (tel, 212-249-8700; fax, 212-327-4405; e-mail, mpruzanskymd@handsport.us).

Am J Orthop. 2009;38(6):295-299.

Materials and Methods

All cases of lateral epicondylitis surgically treated in Dr. Pruzansky's office practice between October 1986 and December 2005 yielded 28 elbows in 26 patients. Four elbows were excluded, leaving 24 elbows in the study. Patients 18, 23, and 24 were excluded because their follow-up was less than 2 years, and patient 17 was excluded for concurrent radial tunnel syndrome in the ipsilateral extremity (Tables I, II). Only patient 12 had an underlying musculoskeletal disorder, type II Ehlers-Danlos. All patients had symptoms of tenderness to palpation over the common extensor tendon at its origin on the lateral epicondyle, pain over the lateral side of the elbow with activities, and pain localized to the lateral epicondyle during resisted wrist extension with full elbow extension. One patient underwent a plicectomy of the radiocapitellar joint for preoperative pain to palpation. None had crepitus or instability with elbow motion.[16,33] Patients complained that the condition significantly interfered with their ability to work, play sports, and engage in activities of daily living.

At symptom onset, 8 patients were engaged in athletic activities, 6 patients (7 elbows) were engaged in strenuous activities, 4 were engaged in low-strain work-related activities, 4 were engaged in housework, and 1 had suffered trauma to the elbow. Mean age at time of surgery for the 7 men and 17 women (1 woman had bilateral disease) was 42.5 years (range, 20-63 years). Seventeen patients presented with right-hand–dominant symptoms, 1 presented with left-hand–dominant symptoms, 1 presented with bilateral disease, and, in 5 cases (21%), the nondominant-side elbow presented as symptomatic (Table I). Repair techniques were direct repair of débrided tendon edges to bone through bone tunnels, reattachment of avulsed extensor tendon origin with suture anchors, or reattachment to

Table I. Demographics

Patient	Age (y)	Sex	Dominance	Affected Side	Activity at Onset
1	44	M	R	R	Chainsaw
2	36	F	R	R	Baseball
3	42	F	L	L	Operating room nurse
4	44	M	R	R	Tennis
5	21	F	R	R	Housework
6	33	M	R	R	Television camera/tennis
7	45	F	R	R	Tennis
8	53	F	R	L	Housework
9	20	F	R	R	Housework
10	42	F	R	R	Dental/gardening
11	51	F	L	R	Activities of daily living
12	36	F	R	L	Artwork[a]
13	43	F	R	R	Housework
14	41	F	R	R	Hairstyling
15	52	F	R	R	Tennis
16	46	F	R	R	Tennis
17	48	F	R	L	Tennis
18	37	F	R	R	Housework/tennis
19	55	F	R	L	Snow shoveling
20	50	F	R	R	Lifting trays
21	35	M	R	R	Tennis
22	54	M	R	R	Tennis
23	46	M	L	R	Electrician
24	28	M	R	L	Hauling lines
25	63	M	R	R	Porter
26	54	F	R	L	Landscaping
27	55	F	R	R	Landscaping
28	54	M	R	R	Golf/tennis

[a]Type II Ehlers-Danlos.

Table II. Duration of Preoperative and Postoperative Symptoms, and Surgical Technique

Patient	Preoperative Treatment (mo)	Postoperative Time to Painless: Use (mo)[a]	Postoperative Time to Painless: Touch (mo)	Follow-Up (mo)	Surgical Materials
1	12	8	11	98	Sutures
2	18	4	5	79	Sutures
3	16	6	6	60	Sutures
4	19	4	1	61	Sutures
5	26	6	6	30	Sutures
6	14	4	4	130	Sutures
7	27	5	5	39	Sutures
8	13	4	4	36	Sutures
9	26	3	6	30	Sutures
10	13	4	5	25	Sutures
11	6	6	6	24	Anchor
12	3	2	2	108	Anchor
13	6	3	4	69	Anchor
14	30	2	2	34	Sutures
15	14	2	2	35	Anchors
16	6	4	4	97	Sutures
17	18	2	5	97	Sutures
18[b]	12	—	—	—	Sutures
19	17	8	8	43	Sutures
20	4.5	3	7	63	Anchor
21	4.5	2	2	120	Sutures
22	36	4	4	24	Sutures
23[b]	40	2	Continuing	3+	Anchor
24[b]	8	4	4	4	Anchor
25	11	2	4	60	Anchor
26	24	2	3	141	Sutures
27	36	4	5	128	Sutures
28	36	4	4	24	Sutures

[a]Full preinjury activity level. [b]Patient excluded because of follow-up <24 months.

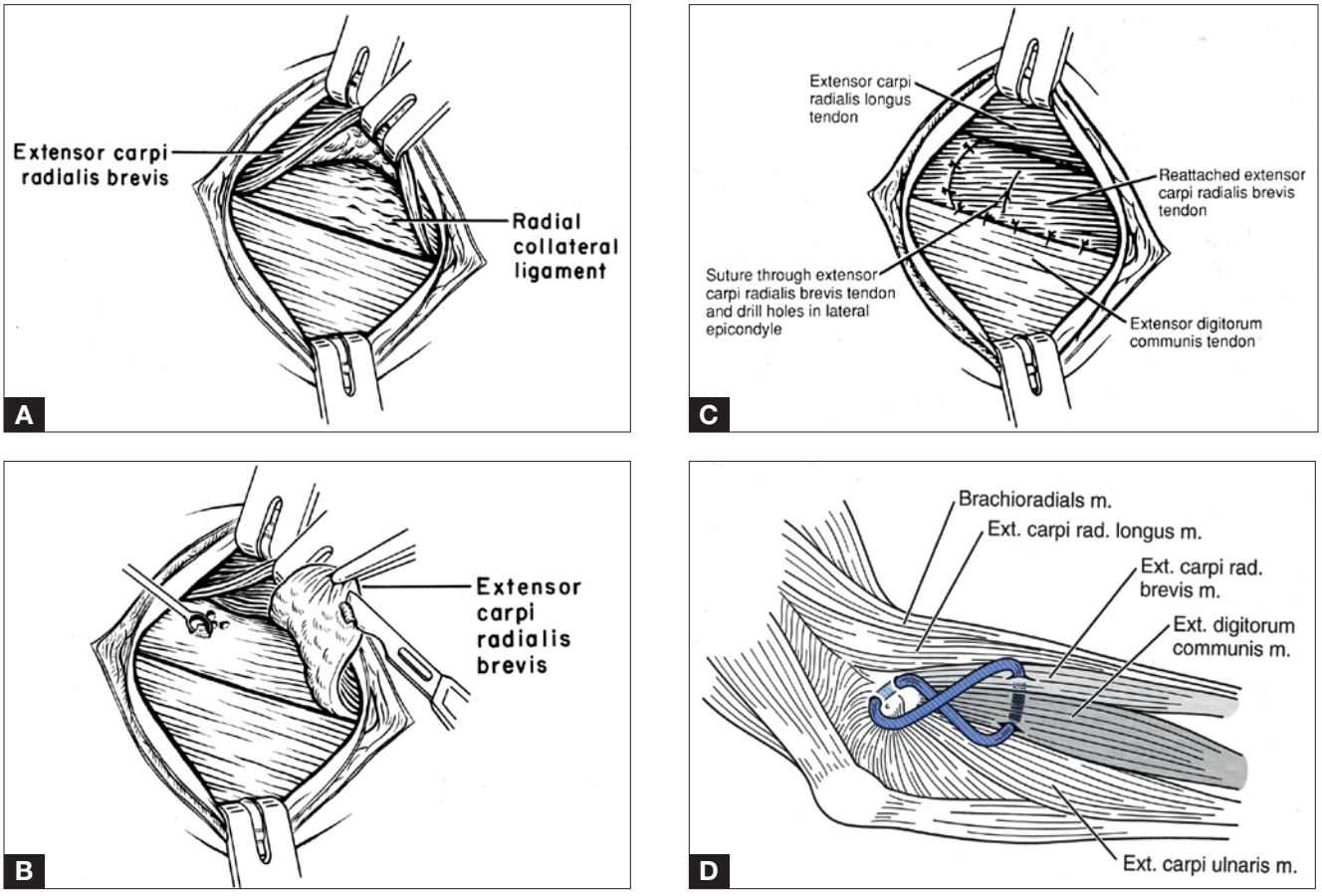

Figure. Reattachment of common extensor tendon origin to bone. (A) Elevate tendon and remove gray scar tissue from undersurface of extensor carpi radial brevis tendon "pocket." (B) Full-thickness tendon débridement may be needed, leaving a distally based flap; lightly decorticate anterior bony ridge. (C) Suture tendon(s) to bone using bone tunnel or suture anchor. (D) Graft tendon from distal stump to origin. Abbrevations: ext., extensor; m., muscle; rad., radialis. (A,B,D) reproduced with permission from: Pruzansky ME. Stenosing tenosynovitis and epicondylitis. In: Chapman MW, ed. *Chapman's Orthopedic Surgery.* Vol. 2. 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2001:1515-1531. Copyright 2001, Lippincott Williams & Wilkins.

bone with autologous tendon graft with suture anchors. Before January 1998 (patient 12), the graft was not used as an option. Mean duration of preoperative treatment was 17.4 months (range, 3-36 months). Nonsurgical treatments included physical therapy, ergonomic adjustments in daily activities, counterforce bracing, use of oral anti-inflammatory medications, and local injections of corticosteroids. All patients had normal radiographs of the symptomatic elbow. Postoperative follow-up office visits and phone calls were used to assess progress of recovery. Mean follow-up was 64.7 months (range, 24-141 months).

Operative Technique

After administration of a regional block anesthesia, a 3.5-cm incision is made centered over the radiocapitellar joint. The subcutaneous tissues are freed to mobilize the skin and increase the scope of the surgical exposure. The antebrachial fascia is incised, and the extensor carpi radialis longus is retracted anteriorly. The muscle belly of the extensor carpi radialis brevis is traced proximally to the extensor tendon of origin. Damage to the extensor carpi radialis brevis and longus and to the digitorum communis is assessed. Although avulsion is usually limited to the extensor carpi radialis brevis, the extensor digitorum communis is the next most frequently observed tendon to be partially torn.

Chronic inflammatory changes or friable scar tissue may be seen in the proximal margin of the extensor tendon. Loss of visible collagen bundles and partial replacement by softened, gray-white, translucent scar tissue may be noted in the diseased tendon. The undersurface of the extensor tendon must also be examined if the tendon has a grossly normal appearance. The tendinous origin of the extensor carpi radialis brevis is often found to be avulsed partially and sometimes completely from the lateral epicondyle. The avulsion may form a pocket on the deep surface of the tendon(s) where it is separated from its bony attachment to the lateral epicondyle (Figure, A). Therefore, a longitudinal incision is made between its aponeurotic and tendinous connection with the communis, the longus, or both. The damaged area is elevated off the bone. This usually takes little effort, as it is partially avulsed. The margins of attachment of normal tissue need to be retained. The tendon may need to be elevated as a distally based flap to complete the débridement (Figure, B). The radial collateral ligament is protected at its origin. When radiocapitellar disease is suspected from a painful preoperative examination, the joint is

inspected through a small incision in the synovium anterior to the radial collateral ligament. Scarred portions of the extensor tendon(s) and granulation tissue are débrided off healthy tendon. If necessary, calcifications, bone chips, and exostoses are removed at this time (though none were noted in this operated group). The lateral epicondyle is lightly decorticated with a fine burr or curette down to punctate, bleeding cortical bone. Two drill holes are made; they are separated by a 5-mm cortical bridge and connected by a tunnel. Angling the drill bits toward each other while making the holes, and connecting them with a towel clip, completes preparation of the fixation point. If the tendon has been shortened during débridement, a slightly more distal fixation point is used. The elbow is flexed to 90°, and the wrist is placed in neutral when choosing the fixation point to the lateral epicondyle. A vertical mattress suture of slowly absorbable 2-0 suture material is first passed through the extensor tendon. The suture is then passed through the bony tunnel and finally back through the tendon before being tied over the tendon with the wrist extended (Figure, C). Alternatively, a single drill hole can be made for placement of a suture anchor. The 2 sutures from the anchor are then passed individually through the extensor tendon and tied over the tendon to secure attachment. Additional sutures are used to fix the tendinous origin of the extensor carpi radialis brevis to the surrounding periosteum and to the tendons of the communis and longus (and, in the case of severely damaged tendons, to the extensor carpi ulnaris). The subcutaneous tissues are closed with interrupted, absorbable 4-0 sutures, and the skin with a running intracuticular steel 5-0 suture.

When damage to the tendons is so great that after débridement the common extensors do not reach proximally to the distal lateral ridge, a tendon graft is taken to complete the reattachment procedure. Graft is taken from the palmaris longus; if palmaris longus is not available, half the diameter of the flexor carpi radialis can be used. The graft is woven through the common origin of the extensor digitorum communis and the extensor carpi radialis brevis tendons in a figure-of-8 construct for narrow defects (Figure, D). Two suture anchors 5 mm apart, anteroposterior, are placed into the appropriate points of origin on the anterolateral epicondylar ridge. The graft is sewn to the anchors and doubled back with No. 2 polyester sutures (Minilok QuickAnchor Plus with 2-0 Ethibond; DePuy Mitek, Raynham, Mass) to affix the graft to the lateral epicondyle and to itself, forming an oval construct for broader defects. The graft should allow for full range of motion with moderate tension. The remaining tendon repair and closure are the same as the simple repair.

After surgery, the extremity is immobilized for 2 weeks (2.5 weeks with a graft) in a long arm splint with the elbow flexed to 90°, the forearm in neutral rotation, and the wrist extended 20°. After splinting, active range-of-motion exercises are begun and continue for 6 more weeks. Resistive exercises are then started and progressed slowly to strengthen the arm. Return to maximum activity level is delayed 4 to 6 months after surgery, depending on degree of extensor tendon quality, original detachment, and security of the bony reattachment of the extensor tendon at time of surgery.

Results

During surgery, all 24 elbows (22 patients) demonstrated gross signs of tendon damage, exemplified by gray-white scar tissue proximal and between visible bundles of collagen. Patient 3 had a more extensive proximal avulsion. This patient also suffered from the only postoperative complication, an ipsilateral subacromial bursitis, which was successfully treated conservatively. No patient lost motion permanently. Patient 7, who had lacked 15° of extension before surgery, recovered a range of motion at 21 months equal to that of the other arm. Finally, patient 17 had both radial tunnel syndrome and lateral epicondylitis, which were repaired in the same surgery (this patient was excluded from the study). Eighteen patients had reattachment with absorbable sutures, 3 had suture anchors, and 3 required autologous tendon graft.

Office follow-up visits were used for monitoring of healing and for prescribing appropriate postoperative physical therapy. Patients were given physical examinations and were questioned about activity levels, strength, and pain. Mean time to full, painless preinjury level of use of the elbow was 4.3 months (range, 3-8 months) for patients who underwent simple repair and 2.75 months (range, 2-4 months) for patients repaired with a graft. Mean time to disappearance of tenderness to touch of the lateral epicondyle was 4.9 months (range, 1-11 months) for patients who underwent simple repair and 4.3 months (range, 2-7 months) for patients repaired with a graft.

Discussion

We have described an operation for treating chronic lateral epicondylitis in which damaged lateral extensor tendons of the elbow are firmly reattached to bone.[34] This technique was previously described by Dr. Pruzansky.[20,35]

The presenting symptom was pain in all cases, and relief from pain after failed treatment was the indication for surgery.[30] Informed consent was obtained from all patients.[36,37] Mean pain-free, completely functional recovery time was 4.3 months for simple repairs (range, 2-8 months) and 2.75 months for repairs that included grafts (range, 2-4 months). All patients included in the study reported that they were satisfied with their results and that they were able to return to their preinjury levels of activity. At her final follow-up visit, patient 18 (excluded from the study for lack of follow-up) indicated she was not entirely satisfied with her result. Her dissatisfaction is notable in that she received far more injections (12) over the lateral epicondyle than is appropriate. In addition, at time of surgery, her reattachment was created nonanatomically distal. These situations may explain her incomplete pain relief.

As in the repair or reconstruction of other ligaments and tendons, restoration of the anatomical or near-anatomical origin of the extensor tendons should give the best results. Our

patients reported no loss of strength with resumption of their preinjury level of activities. Mean full recovery time varies according to patient lifestyle. Office follow-up time varied among patients as well, affecting the temporal outcome for loss of pain to touch and to resisted wrist extension.

Our study had a few limitations. It was a retrospective review with no control group, so we cannot definitively state that our technique is superior to others. We do not have any standardized scores (eg, Disabilities of the Arm, Shoulder, and Hand scores) that would allow us to better objectively evaluate our patients' improvement. The limited number of patients included in this study also reduces the predictive value of the analysis in attaining similar results in all future patients. Delay in loss of pain to palpation of the lateral epicondyle in comparison with loss of pain to use suggests that the difference is related to healing nerve fibers. Rapid recovery of grafted patients suggests that pain relief is related to extensive, complete removal of damaged tendon and nerve fibers and to stabilization of all tendon units. By comparison, the anconeus transfer would seem to offer less stiffness to the reconstruction.[38] The importance of the more rapid recovery of grafted patients is unclear in view of their limited number. The relatively rapid return of anatomically reconstructed elbows to full function strongly suggests predictable, reliable results with this technique.

Authors' Disclosure Statement and Acknowledgments

The authors report no actual or potential conflict of interest in relation to this article.

The authors acknowledge Joel Williams for his assistance in creating the tables.

References

1. Nirschl RP, Pettrone FA. Tennis elbow. The surgical treatment of lateral epicondylitis. *J Bone Joint Surg Am*. 1979;61(6):832-839.
2. Aoki M, Wada T, Isogai S, Kanaya K, Aiki H, Yamashita T. Magnetic resonance imaging findings of refractory tennis elbows and their relationship to surgical treatment. *J Shoulder Elbow Surg*. 2005;14(2):172-177.
3. Curnmins C. Lateral epicondylitis. *Am J Sports Med*. 2006;34:1486-1491.
4. Edwards SG, Calandruccio JH. Autologous blood injections for refractory lateral epicondylitis. *J Hand Surg Am*. 2003;28(2):272-278.
5. Gartsman GM, Hasan SS. What's new in shoulder and elbow surgery. *J Bone Joint Surg Am*. 2002;84(1):151-156.
6. Gartsman GM, Hasan SS. What's new in shoulder and elbow surgery. *J Bone Joint Surg Am.* 2003;85(1):171-181.
7. Gartsman GM, Hasan SS. What's new in shoulder and elbow surgery. *J Bone Joint Surg Am.* 2004;86(1):189-202.
8. Gartsman GM, Hasan SS. What's new in shoulder and elbow surgery. *J Bone Joint Surg Am.* 2006;88(2):230-243.
9. Haake M, König IR, Decker T, Riedel C, Buch M, Müller HH; Extracorporeal Shock Wave Therapy Clinical Trial Group. Extracorporeal shock wave therapy in the treatment of lateral epicondylitis: a randomized multicenter trail. *J Bone Joint Surg Am*. 2002;84(11):1982-1991.
10. Hayton MJ, Santini AJ, Hughes PJ, Frostick SP, Trail IA, Stanley JK. Botulinum toxin injection in the treatment of tennis elbow. A double-blind, randomized, controlled, pilot study. *J Bone Joint Surg Am*. 2005;87(3):503-507.
11. Meyer NJ, Walter F, Haines B, Orton D, Daley RA. Modeled evidence of force reduction at the extensor carpi radialis brevis origin with the forearm support band. *J Hand Surg Am*. 2003;28(2):279-287.
12. Miller MD. What's new in sports medicine. *J Bone Joint Surg Am*. 2004;86(3):653-661.
13. Mishra A, Pavelko T. Treatment of chronic elbow tendinosis with buffered platelet-rich plasma. *Am J Sports Med*. 2006;34(11):1774-1778.
14. Montgomery SC, Miller MD. What's new in sports medicine. *J Bone Joint Surg Am*. 2005;87(3):686-694.
15. Nirschl RP, Rodin DM, Ochiai DH, Maartmann-Moe C; DEX-AHE-01-99 Study Group. Iontophoretic administration of dexamethasone sodium phosphate for acute epicondylitis. A randomized, double-blinded, placebo-controlled study. *Am J Sports Med*. 2003;31(2):189-195.
16. Paoloni JA, Appleyard RC, Murrell GA. The Orthopaedic Research Institute–Tennis Elbow Testing System. A modified chair pick-up test—interrater and intrarater reliability testing and validity for monitoring lateral epicondylitis. *J Shoulder Elbow Surg*. 2004;13(1):72-77.
17. Paoloni JA, Appleyard RC, Nelson J, Murrell GA. Topical nitric oxide application in the treatment of chronic extensor tendinosis at the elbow: a randomized, double-blinded, placebo-controlled clinical trial. *Am J Sports Med*. 2003;31(6):915-920.
18. Pettrone FA, McCall BR. Extracorporeal shock wave therapy without local anesthesia for chronic lateral epicondylitis. *J Bone Joint Surg Am*. 2005;87(6):1297-1304.
19. Pomerance J. Radiographic analysis of lateral epicondylitis. *J Shoulder Elbow Surg*. 2002;11(2):156-157.
20. Pruzansky ME, Karas EH. Lateral extensor reattachment to bone for tennis elbow. Poster presented at: National Meeting of the American Association of Orthopaedic Surgeons; 1994; New Orleans, LA.
21. Ring D, Guss D, Malhotra L, Jupiter JB. Idiopathic arm pain. *J Bone Joint Surg Am*. 2004;86(7):1387-1391.
22. Rompe JD, Decking J, Schoellner C, Theis C. Repetitive low-energy shock wave treatment for chronic lateral epicondylitis in tennis players. *Am J Sports Med*. 2004;32(3):734-743.
23. Rubenthaler F, Wiese M, Senge A, Keller L, Wittenberg RH. Long-term follow-up of open and endoscopic Hohmann procedures for lateral epicondylitis. *Arthroscopy.* 2005;21(6):684-690.
24. Rubino LJ 3rd, Miller MD. What's new in sports medicine. *J Bone Joint Surg Am*. 2006;88(2):457-468.
25. O'Driscoll SW. Physiotherapy or a wait-and-see policy were best long-term treatment options for lateral epicondylitis. *J Bone Joint Surg Am*. 2002;84(8):1487.
26. Smith AM, Castle JA, Ruch DS. Arthroscopic resection of the common extensor origin: anatomic considerations. *J Shoulder Elbow Surg*. 2003;12(4):375-379.
27. Steinmann SP, King GJW, Savoie FH. Arthroscopic treatment of the arthritic elbow. *J Bone Joint Surg Am*. 2005;87(9):2113-2121.
28. Struijs PA, Kerkhoffs GM, Assendelft WJ, Van Dijk CN. Conservative treatment of lateral epicondylitis: brace versus physical therapy or a combination of both—a randomized clinical trial. *Am J Sports Med*. 2004;32(2):462-469.
29. Tasto JP, Cummings J, Medlock V, Hardesty R, Amiel D. Microtenotomy using a radiofrequency probe to treat lateral epicondylitis. *Arthroscopy*. 2005;21(7):851-860
30. Uchio Y, Ochi M, Ryoke K, Sakai Y, Ito Y, Kuwata S. Expression of neuropeptides and cytokines at the extensor carpi radialis brevis muscle origin. *J Shoulder Elbow Surg*. 2002;11(6):570-575.
31. Walther M, Kirschner S, Koenig A, Barthel T, Gohlke F. Biomedical evaluation of braces used for the treatment of epicondylitis. *J Shoulder Elbow Surg*. 2002;11(3):265-270.
32. Wang C, Chen H. Shock wave therapy for patients with lateral epicondylitis of the elbow. *Am J Sports Med*. 2002;30(3):422-425.
33. Kalainov DM, Cohen MS. Posterolateral rotary instability of the elbow in association with lateral epicondylitis. *J Bone Joint Surg Am.* 2005;87(5):1120-1125.
34. Thornton SJ, Rogers JR, Prickett WD, Dunn WR, Allen AA, Hannafin JA. Treatment of recalcitrant lateral epicondylitis with suture anchor repair. *Am J Sports Med*. 2005;33(10):1558-1564.
35. Pruzansky ME. Stenosing tenosynovitis. In: Chapman M, ed. *Operative Orthopedics*. 2nd ed. Philadelphia, PA: Lippincott; 1994:1226-1228.
36. Kelly EW, Morrey BF, O'Driscoll SW. Complications of elbow arthroscopy. *J Bone Joint Surg Am.* 2001;83(1):25-34.
37. Shapiro GS, Weiland AJ. Reactive bone formation after surgery for lateral epicondylitis. *J Shoulder Elbow Surg*. 2002;11(4):383-385.
38. Morrey BF, Schneeberger AG. Anconeus arthroplasty: a new technique for reconstruction of the radiocapitellar and/or proximal radioulnar joint. *J Bone Joint Surg Am*. 2002;84(11):1960-1969.