

Sonographically Guided Percutaneous Needle Tenotomy for Treatment of Common Extensor Tendinosis in the Elbow

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Objective. Chronic tendinosis of the common extensor tendon of the lateral elbow can be a difficult problem to treat. We report our experience with sonographically guided percutaneous needle tenotomy to relieve pain and improve function in patients with this condition. **Methods.** We performed sonographically guided percutaneous needle tenotomy on 58 consecutive patients who had persistent pain and disability resulting from common extensor tendinosis. Under a local anesthetic and sonographic guidance, a needle was advanced into the common extensor tendon, and the tip of the needle was used to repeatedly fenestrate the tendinotic tissue. Calcifications, if present, were mechanically fragmented, and the adjacent bony surface of the apex and face of the epicondyle were abraded. Finally, the fenestrated tendon was infiltrated with a solution containing corticosteroid mixed with bupivacaine. After the procedure, patients were instructed to perform passive stretches and to undergo physical therapy. During a subsequent telephone interview, patients answered questions about their experience, their functioning level, and their perceptions of procedure outcome. **Results.** Fifty-five (95%) of 58 patients were contacted by telephone and agreed to participate in the study. Thirty-five (63.6%) of 55 respondents reported excellent outcomes, 16.4% good, 7.3% fair, and 12.7% poor. The average follow-up time from the date of the procedure to the date of the interview was 28 months (range, 17–44 months). No adverse events were reported; 85.5% stated that they would refer a friend or close relative for the procedure. **Conclusions.** Sonographically guided percutaneous needle tenotomy for lateral elbow tendinosis is a safe, effective, and viable alternative for patients in whom all other nonsurgical treatments failed. **Key words:** common extensor tendon; elbow; needle; sonography; tennis elbow; tendinosis.

Abbreviations

CET, common extensor tendon

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Tendinosis of the common extensor tendon (CET) of the elbow (“tennis elbow”) is a common cause of elbow pain in adults. Although symptoms often spontaneously resolve, some patients will have prolonged pain and dysfunction. The literature describes a variety of techniques¹ to treat this condition, including open surgical debridement of the extensor carpi radialis brevis,² percutaneous release,³ and arthroscopic debridement.^{4,5} Also, multiple alternative therapies have been reported, including extracorporeal shock waves,^{6–8} autologous blood injection,⁹ laser treatment,¹⁰ and botulinum toxin injection.¹¹ The fact that there are so many different approaches to the management of this problem suggests that no single treatment has gained universal acceptance.

Ideal treatment for recalcitrant tendinosis of the CET would be convenient, minimally invasive, low cost, low risk, and long lasting. Previous authors have reported success with percutaneous approaches involving needle puncture of the CET.¹² However, these procedures were performed blindly. Because it enables direct visualization of tissues and instruments being used, sonographic guidance could potentially improve the efficacy of percutaneous procedures and prevent damage to other structures, such as the lateral ligament complex. Here we report our experience with sonographically guided percutaneous needling, or "tenotomy," for treating common extensor tendinosis.

Materials and Methods

Patients

Between May 1999 and August 2003, we performed sonographically guided percutaneous needle tenotomy on 58 consecutive patients with persistent pain and disability from tendinosis of the CET. The average duration of symptoms was 9 months (range, 2–24 months). All 58 individuals were patients of 1 author (J.M.M.) before undergoing the procedure. All patients with recalcitrant symptoms and who had findings on sonography were offered a procedure after failure of at least 3 of the following 5 nonsurgical treatment modalities: corticosteroid injection, nonsteroidal anti-inflammatory medications, counterforce bracing, physical therapy, and cock-up wrist splinting. The patients' natural histories had been established by the fact that they had persistent, unresolved pain. There was no specific pain intensity measure used to ascertain the level of pain.

Inclusion Criteria

1. Either sex and any ethnicity or age; and
2. Discomfort localized to the lateral elbow and physical examination findings meeting the following criteria: (A) tenderness localized to the CET and (B) pain with resisted wrist extension, particularly with the affected elbow in full extension.

Exclusion Criteria

1. Coexisting conditions affecting the elbows (eg, rheumatoid arthritis and cervical radiculopathy).

Of the patients who underwent the procedure, 55 (95%) of 58 were contacted by telephone and agreed to participate in the study. The other 3

could not be reached. The patients answered questions about their experience with the procedure and their perceptions of procedure outcome. Six patients had both elbows treated. To keep the data consistent, we analyzed only the outcome of the elbow that had been more symptomatic before treatment. Each patient's outpatient chart was reviewed. This study was approved by, and carried out in accordance with, guidelines set by the Institutional Review Board at our institution. All patients provided informed consent before answering any study-related questions.

Sonographic Scanning

Evaluation and treatment of all patients was performed in the ultrasound suite at the Department of Radiology of our institution. A radiologist (L.N.N.) with 10 years of experience in musculoskeletal sonography initially performed a diagnostic sonographic examination of the CET with the patient reclined and the elbow resting at the side. Sonographic scans were performed using multifrequency linear array transducers with peak frequencies of 12 to 15 MHz on commercially available sonography units, an HDI 5000 (Philips Medical Systems, Bothell, WA) or a Sonoline Elegra (Siemens Medical Solutions, Issaquah, WA). Images were recorded on hard copy films until January 2001, after which time images were recorded on a picture archiving and communications system (Canon Medical Systems, Lake Success, NY).

Comparison sonographic studies of both elbows were performed for all patients. The CET was identified in the long axis with the use of the radiocapitellar joint and lateral epicondyle as bony acoustic landmarks (Figure 1A). Tendinosis was diagnosed by 1 or more of the following findings: tendon thickening, heterogeneity, hypoechoic foci, intrasubstance tears (defined as linear hypoechoic foci associated with discontinuity of tendon fibers), calcifications, and enthesiophytes at the tendon attachment.¹³ Only patients who had tendinosis as shown on sonography underwent the procedure. Palpation was used to correlate sonographic findings with patients' pain and tenderness.

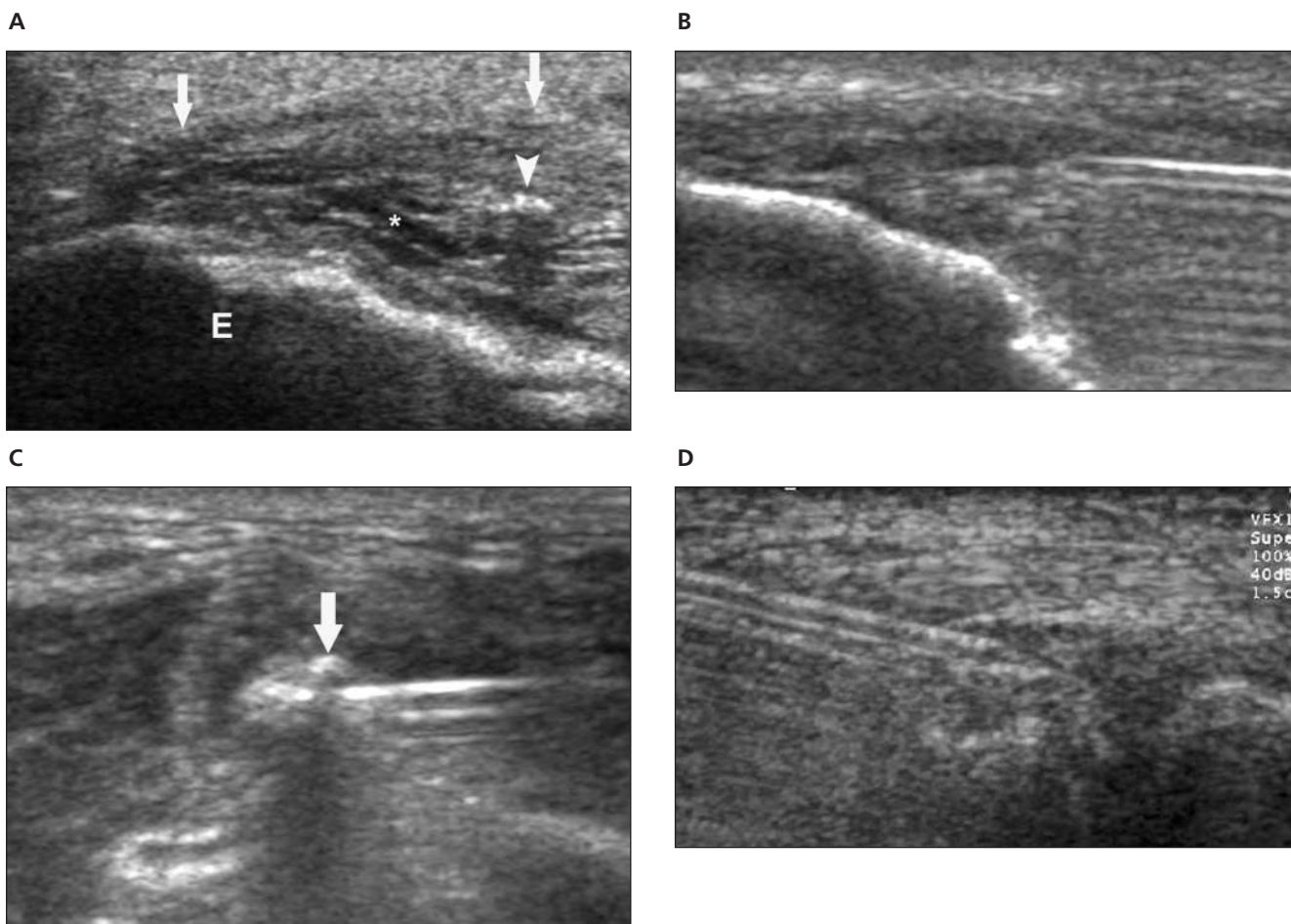
Procedure

During the procedure, all sonographic scanning and guidance were done by either the radiologist (L.N.N.) or a sonographer, and all injections and needling were done by the lead author (J.M.M.).

After informed consent had been obtained from the patient, the site to be injected was prepared with isopropyl alcohol and then sprayed with ethyl chloride to achieve cutaneous anesthesia. Next, with continuous sonographic visualization, the skin and subcutaneous tissues overlying the lateral epicondyle were infiltrated with 0.5% bupivacaine (Marcaine; Abbott Laboratories, North Chicago, IL) and 1% sodium bicarbonate (50 mEq/50 ml; American Reagent Laboratories, Shirley, NY) using a 20- or 22-gauge hypodermic needle. Anesthetic solution was also instilled directly into the CET and periosteum of the lateral epicondyle.

Once adequate anesthesia was achieved, another needle (either 18 or 20 gauge) was used to repeatedly fenestrate the tendinotic tendon. The needle was passed parallel to the longitudinal plane of the tendon from an inferior to superior approach (Figure 1B). Initial passes through the tendon were typically met with resistance and would produce palpable and audible crepitation. As the needle was passed repeatedly, the tissue would soften, and crepitation would diminish. If present, calcifications within the substance of the tendon, enthesiophytes at the tendon origin, or both were mechanically fragmented (Figure 1C). When it was determined

Figure 1. Images from a 64-year-old man with chronic right lateral elbow pain limiting his ability to play tennis. After treatment, the patient recovered fully within 12 weeks and remained asymptomatic 4 years later. **A**, Longitudinal sonogram of the lateral elbow shows thickening and heterogeneity of the CET (arrows) consistent with tendinosis, with intrasubstance tears (asterisk), calcifications (arrowhead), and marked irregularity of the lateral epicondyle (E). **B**, An 18-gauge needle has been advanced into the tendon substance. The tip of the needle was subsequently used to fenestrate the tendon, break up the calcifications, and abrade the bony margin. **C**, The needle is shown breaking off an enthesiophyte (arrow) from the lateral epicondyle. **D**, The needle is then inserted into the tendon from a superior to inferior approach, which makes it easier to place the needle tangential to the plane of the lateral epicondyle. The bony irregularity was subsequently abraded with the needle tip.



that the entire tendon had been treated by sonographic visualization and by palpable softening of the tissue, the needle was removed.

In all patients, the needle was then reinserted from a superior to inferior approach, again parallel to the tendon long axis (Figure 1D). This approach enabled the needle to be more tangential to the plane of the lateral epicondyle. Under continuous sonographic visualization, the needle tip was used to abrade the periosteum of the lateral epicondyle. This was done by using the needle's bevel to scrape the edge of the bone and to smooth any irregularities in the bone, as well as to detach and fragment any enthesiophytes. The epicondyle and its downward slope were repeatedly abraded until it appeared that the entire attachment point of the CET had been smoothed.

Finally, the tendon was injected with 1 mL of corticosteroid, either 6 mg of betamethasone (Celestone Soluspan; Schering-Plough, Kenilworth, NJ) or 40 mg of triamcinolone acetonide (Kenalog-40; Bristol-Myers Squibb, Princeton, NJ), mixed with 2 mL of 0.5% bupivacaine. The needle was then withdrawn, and an adhesive bandage was placed over the needle puncture site.

After the procedure, patients were instructed to apply ice to the treated area up to 5 times daily for the first 2 weeks and to passively stretch the tendon as often as possible. Patients were restricted from lifting more than 5 pounds and were instructed to refrain from excessively repetitive movements in the treated arm during the initial 2 weeks. After 2 weeks, physical therapy was started, and patients were instructed to gradually return to their normal activities and work toward restoring full elbow function. Patients were followed by 1 author (J.M.M.) at approximately 2-week intervals for 12 weeks.

Subjective Evaluation

For assessment of clinical and functional outcomes of this treatment, patients were contacted by telephone, and a questionnaire was orally administered. The questionnaire was developed by modification of the Patient-Rated Forearm Evaluation Questionnaire.¹⁴ This questionnaire uses a 10-point visual numeric scale to assess pain levels and difficulty performing specific activities. Because this questionnaire was delivered via telephone, we eliminated the 10-point visual scale and asked patients to report their pain over the past week on a 4-point scale ("none,"

"mild," "moderate," or "severe") on a per-treated-elbow basis.

Also on a per-elbow basis, we asked patients to categorize their ability to perform various tasks over the past week on a 4-point scale ("no difficulty," "mild difficulty," "moderate difficulty," or "unable to do"). On a per-patient basis, we asked about perception of overall procedure-related improvement using the following classification scheme: excellent if "very happy with the procedure and had no room for improvement," good if "happy with the outcome but had some room for improvement," fair if "slight dissatisfaction with the outcome of the procedure and had room for significant improvement," or poor if "dissatisfied with the outcome of the procedure and had little or no improvement." Questions were related specifically to the time at which the telephone call was conducted.

The data were entered into a database and analyzed with the SAS 6.0 program (SAS Institute Inc, Cary, NC). Descriptive statistics were calculated for the patient group. The Fisher exact test was used to determine whether there were nonrandom associations between procedure outcome and the following categorical variables: dominant versus nondominant extremity, age, whether injury was work related, duration of symptoms before the procedure, and time between the procedure and the follow-up telephone call.

Results

During the procedure, the patients tolerated the needling quite well. As one would expect, the initial infiltration of the anesthetic was mildly uncomfortable. Once the elbow was anesthetized, however, there was very little discomfort. Although we did not systematically time the duration of the procedure, the time from initial instillation of the anesthetic to withdrawal of the final needle, on average, lasted approximately 15 to 20 minutes. There were no immediate complications in any patients.

As Table 1 indicates, of the 55 patients interviewed, there were 30 women and 25 men with an age range of 33 to 78 years (mean, 49 years). Forty (72.7%) of the 55 patients had received prior steroid injections, and 51 (92.7%) had undergone physical therapy. Of the patients who had steroid injections, 85% had also failed physical therapy. Bilateral treatments (done at least 3 months apart) were performed in 6 patients, for

Table 1. Patient Demographic and Clinical Characteristics

Characteristic	n (%)
Male/female	30 (54.5)/25 (45.5)
Treatment being attempted before procedure*	
Steroid injections	40 (72.7)
Nonsteroidal anti-inflammatory medications	44 (80.0)
Physical therapy	51 (92.7)
Tennis elbow braces	32 (58.2)
Non-image-guided steroid injections	30 (54.5)
Cock-up splints	12 (21.8)
Other treatments	6 (10.9)
Right-handed/left-handed†	48 (87.3)/3 (5.5)
Time from onset of symptoms to procedure, mo	
1–3	1 (1.6)
3–6	14 (23.0)
6–9	13 (21.3)
9–12	9 (14.8)
>12	24 (39.3)
Mean age (range), y	49 (33–78)

*Previous treatment categories are not mutually exclusive because most patients had more than 1 type of treatment before the procedure.

†One patient was ambidextrous, and for 3, data were unavailable.

a total of 61 elbows. Forty-six (75.4%) of 61 elbows were symptomatic for more than 9 months before the needle procedure. Most patients identified themselves as right-handed. Of the 48 right-handed patients, 62.5% had only their right arm treated; 25% had only their left arm treated; and 12.5% had bilateral treatments.

Sonographic Findings

Sonographic reports of 53 of 55 patients were successfully retrieved. All 53 of the sonographic reports described tendon thickening, heterogeneity, and hypochoic foci. Thirty-two (60.4%) of the 53 reports noted calcifications within the CET; 31 (58.5%) noted intrasubstance tears; and 14 (26.4%) noted the presence of enthesiophytes.

Subjective Evaluation

The average follow-up time from date of the procedure to date of the interview was 28 months (range, 17–44 months). As indicated in Table 2, 48 (81.4%) of 61 elbows were reported as having no pain at rest over the past week. Fifty-five (93.2%) of 59 elbows never had pain that woke the patients at night. Over the past week, the worst level of pain was “none” or “mild” in 44 (78.5%) of 56 elbows. The per-elbow functional data gathered from telephone questionnaires are summarized in Table 3. In aggregate, 86.3% (422/489) of the responses were “no difficulty,” 8% “mild difficulty,” 2.2% “moderate difficulty,” and 3.5% “unable to do.”

As reported in Table 4, 63.6% (35/55) of respondents reported excellent outcomes, 16.4% good, 7.3% fair, and 12.7% poor. There was no significant relationship between the following parameters and outcome: dominant versus nondominant extremity, age, whether injury was work related, duration of symptoms before the procedure, and time between the procedure and the follow-up telephone call. However, for women treated on their dominant elbows, the response was significantly ($P < .05$) worse than for men; for nondominant elbows, this relationship was not seen ($P = .27$). In fact, all poor responses were from women.

Table 2. Responses to the Telephone Interview (n = 59 Elbows)

Response	n (%)
Overall pain over the past wk*	
None	48 (81.4)
Mild	8 (13.6)
Moderate	5 (5.1)
Severe	0 (0.0)
Pain that woke patient at night*	
Frequently	1 (1.7)
Sometimes	3 (5.1)
Never	55 (93.2)
Worst level of pain over the past wk†	
None	32 (57.1)
Mild	12 (21.4)
Moderate	9 (16.1)
Severe	3 (5.4)

*Data were not available for 2 elbows.

†Data were not available for 5 elbows.

Table 3. Responses to Questionnaire Regarding the 61 Treated Elbows in 55 Patients

Task	Difficulty Level, n (%)				
	None	Mild	Moderate	Unable	NA
Turning a doorknob	53 (86.9)	2 (3.3)	0 (0.0)	2 (3.3)	4 (6.6)
Carrying a bag of groceries	45 (73.8)	7 (11.1)	2 (1.3)	2 (1.3)	5 (8.2)
Lifting cup or glass to mouth	53 (86.9)	0 (0.0)	1 (1.6)	2 (3.3)	5 (8.2)
Opening a jar	49 (80.3)	3 (4.9)	1 (1.6)	2 (3.3)	6 (9.8)
Wringing a washcloth	47 (77.0)	6 (9.8)	0 (0.0)	2 (3.3)	6 (9.8)
Vacuuming	41 (67.2)	5 (8.2)	2 (3.3)	2 (3.3)	11 (18.0)
Unloading a dishwasher	50 (82.0)	3 (4.9)	0 (0.0)	2 (3.3)	6 (9.8)
Performing usual job	43 (70.5)	4 (6.6)	4 (6.6)	1 (1.6)	9 (14.8)
Recreation or sports activities	41 (67.2)	9 (14.8)	1 (1.6)	2 (3.3)	8 (13.1)

Patients were asked to rate the degree of difficulty in performing specific tasks over the past week. NA indicates not applicable.

No adverse events were reported in any patients. Forty-seven (85.5%) of 55 stated that they would refer a friend or close relative for the procedure.

Discussion

Chronic elbow pain is a frequent cause of visits to a physician and is most commonly located on the lateral aspect of the elbow. Physical examination usually reveals that the location of the pain is over the origin of the CET. At surgery, the specific tendon involved is most often the extensor carpi radialis brevis.¹⁵ This condition, frequently referred to as either “lateral epicondylitis” or “tennis elbow,” affects men and women equally and appears most commonly in individuals aged 40 to 50 years.¹⁶ Fewer than 10% of those affected with tennis elbow are tennis players.¹⁷ However, 50% of tennis players older than 35 years and 60% of players older than 50 years old will have symptoms of lateral elbow pain at some time in their lives.¹⁵ Most patients with lateral elbow pain report a work- or recreation-related overuse injury. Despite our understanding of activities that can lead to development of this problem, the pathophysiologic mechanisms of this disorder are poorly understood.^{15,18,19}

Although epicondylitis is a term often used to describe this condition, most studies reporting on the histopathologic findings have shown no evidence of either an acute or a chronic inflammatory process.¹⁶ Histologic studies have shown that this disorder is actually the result of tendon degeneration that leads to replacement of normal tissue by a disorganized arrangement of collagen.²⁰⁻²³ This condition is therefore more appropriately referred to as “tendinosis” or “tendinopathy” rather than “tendinitis.”^{20,21,24}

Treatment for tennis elbow includes both non-surgical and surgical techniques. Rest from the offending activity, counterforce bracing to reduce load on the tendon, and physical therapy are all often prescribed. In addition, despite the fact that there is little evidence to suggest an inflammatory process, many clinicians use non-steroidal anti-inflammatory drugs and localized corticosteroid injections. Although corticosteroid injections for lateral elbow tendinosis are frequently used, the scientific evidence to support their use is lacking. There is a general consensus that corticosteroid injections are beneficial when used early in the course of symptoms.⁷ The benefit of corticosteroid use more than 6 weeks after symptom onset is of unclear value because inflammation is not typically seen in more chronic tendinosis. Despite varied attempts at treatment, many patients remain symptomatic after prolonged treatment efforts. If pain is troubling enough, and all other attempts at treatment have failed, some patients undergo surgery to excise tendinotic tissue within the extensor carpi radialis brevis.^{15,17}

Because tendinotic tissue is readily identified on sonography,^{23,25-30} sonographically guided percutaneous interventions have been devel-

Table 4. Overall Satisfaction (n = 55 Patients)

Perception of Overall Outcome	n (%)
Excellent	35 (63.6)
Good	9 (16.4)
Fair	4 (7.3)
Poor	7 (12.7)

oped to treat Achilles, patellar, and rotator cuff tendinosis.²⁹⁻³⁶ For example, in chronic shoulder calcific tendinosis, sonography is used to guide a needle tip to break up and occasionally aspirate calcific deposits.³⁴⁻³⁶ A percutaneous needling procedure similar to ours but without sonographic guidance has also been reported previously.¹² However, sonographic guidance affords several advantages. First, diagnostic sonography allows for confirmation of the diagnosis of lateral elbow tendinosis in cases that are not certain clinically.³⁷ If the sonographic imaging findings are normal, then it would be assumed that the source of pain was not from tendinosis of the CET. The procedure described here would then not be performed. Second, the use of sonography ensures that all abnormal-appearing tissue is treated, and, conversely, normal structures are avoided. In short, we believe that sonographic guidance allows more accurate and comprehensive treatment than can be achieved if the procedure is attempted blindly.³³

In our series of 55 patients, 44 (80%) reported excellent or good results. It is problematic to compare our success rate with those reported from other nonsurgical and surgical treatments. Few head-to-head controlled trials have been performed to date to evaluate the multiple types of procedures available to surgeons.¹⁷ In addition, methods of trials evaluating various nonsurgical modalities for lateral elbow tendinosis were too variable to allow for meaningful quantitative meta-analysis, according to one systematic review.¹⁹

Nonetheless, it has been our opinion that if the procedure described here could have a success rate even close to that reported for surgical treatment, then this procedure would be more desirable. Compared with surgery, this procedure has lower inherent risks because it is less invasive and requires only a local anesthetic. In addition, inconvenience to patients is greatly reduced. There is no need to fast before this procedure, and afterward, patients' arms are never immobilized and may be used for all normal daily activities. Finally, the cost of this procedure is less than if done in an operating room.

Although we administered a corticosteroid after the needling, we are uncertain of its role, and we are currently undertaking a study to determine whether steroid administration is necessary. There are several possible benefits of

corticosteroid administration in this setting. A reduction in postprocedure inflammation may be desired. Furthermore, the catabolic property of corticosteroid preparations may help reduce the amount of thickened, tendinotic tissue. The principle is the same as that applied when treating hypertrophic keloids with intralesional steroid injections.³⁸ Finally, there are chemical mediators of pain that may be inhibited by corticosteroids.³⁹

Alternatively, Altay et al¹² found no significant difference in outcomes of their needling technique between patients who received a steroid and those who did not. It is possible that needling of tendinosis in and of itself achieves a healing response, including blood vessel and collagen precursor recruitment.⁴⁰ Subsequent physical therapy may help prevent adhesions from reforming and may promote newly regenerated collagen to align along lines of stress in an organized, linear fashion.^{33,41} Finally, whereas tendon rupture is a theoretical risk after intra-tendinous steroid injection, this did not occur in any of our patients.

There are limitations to this study, which are mostly due to the fact that data were retrieved rather than recorded as they occurred. Because all our follow-up data were obtained, on average, 28 months after the procedure, from patient self-reports, there is potential recall bias. Nevertheless, we did not find a significant relationship between outcome and time elapsed until the follow-up interview. A better way to evaluate outcomes may be to assess specific functional abilities both before and after the procedure. In addition, objective measures of muscle strength in affected limbs could be taken before and after the procedure. Another limitation of the study was the lack of a control group. Ideally, a prospective, randomized design would compare results of the treatment described in this article with results of other types of treatment. A study comparing this procedure with nonsurgical care was not practical in our patient population because patients who were offered the procedure were already dissatisfied with treatments they had received up to that time. We think that, in this context, failure of those other treatments allowed each patient to serve as his or her own historical control. We also think that a more appropriate analysis would be to compare our procedure with surgical treatment.

In conclusion, sonographically guided percutaneous needle tenotomy for lateral elbow tendinosis is safe and effective and can be performed under local anesthesia on an outpatient basis. For patients in whom other nonsurgical treatments for this condition have failed and who are considering surgery, this procedure may represent a viable alternative. Further prospective studies should help determine who are the most appropriate candidates for the procedure and whether concomitant corticosteroid administration is necessary.

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