

# Radiofrequency Microtenotomy for Elbow Epicondylitis: Midterm Results

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## Abstract

We conducted a prospective, nonrandomized, single-center clinical study to evaluate the safety and midterm effectiveness of microtenotomy using a radiofrequency probe to treat chronic tendinosis of the elbow. All patients had failed conservative treatment for 6 months. The radiofrequency-based microtenotomy was performed using the Topaz Microdebrider (ArthroCare). Patients were followed annually for up to 9 years postoperatively. Pain status was documented using a visual analog scale self-reported measure.

Eighty consecutive patients with tendinosis of the elbow were enrolled; 69 patients were treated for lateral epicondylitis and 11 for medial epicondylitis. The duration of follow-up ranged from 6 months to 9 years (mean, 2.5 years). Ninety-one percent of the patients reported a successful outcome. Within the lateral epicondylitis group, the preoperative visual analog scale improved from 6.9 to 1.3 postoperatively and demonstrated an 81% improvement ( $P \leq .01$ ). For the medial epicondylitis patients, the preoperative visual analog scale improved from 6.1 to 1.3 after surgery, a 79% improvement ( $P \leq .01$ ). No complications were reported.

Radiofrequency-based microtenotomy is a safe and effective procedure for elbow epicondylitis. The results are durable with successful outcomes observed at 9 years after surgery.

microtraumatic events that cause disruption of the internal structure of the tendon and degeneration of the cells and matrix.<sup>4</sup> Lesions caused by chronic overuse are now commonly called *tendinosis* and are not considered inflammatory in nature. Although the term *tendinitis* is used frequently and indiscriminately, histopathologic studies have shown that specimens of tendon obtained from areas of chronic overuse do not contain large numbers of macrophages, lymphocytes, or neutrophils.<sup>5</sup> Rather, tendinosis appears to be a degenerative process that is characterized by the presence of dense populations of fibroblasts, vascular hyperplasia, and disorganized collagen. This constellation of findings has been termed by some authors as *angiofibroblastic hyperplasia*.<sup>6</sup>

Conservative care for the treatment of chronic tendinosis has been well described and is often successful. Treatment consists of rest, ice, compression, and elevation in the acute phase. This can be followed with bracing, activity modification, physical therapy, oral nonsteroidal anti-inflammatory drugs, topical applications, and injections of cortisone or platelet-rich plasma. When conservative treatment fails, surgical intervention may be considered. Procedures for the treatment of lateral epicondylitis include open débridement and release, arthroscopic débridement, percutaneous release, and radiofrequency (RF) coblation. The goals of operative treatment are to resect pathological material, to stimulate neovascularization by producing focused local bleeding, and to create a healthy scar while doing the least possible structural damage to surrounding tissues.<sup>4</sup>

The efficacy of a bipolar RF-based approach for using microtenotomy was first recognized when researchers studied the effects of transmyocardial revascularization for treating congestive heart failure.<sup>7</sup> The use of RF- and laser-based transmyocardial revascularization initiated an angiogenic response in degenerated (ischemic) heart tissue. This success led to investigating the use of a RF-based approach for performing microtenotomy. Preclinical studies demonstrated that RF-based microtenotomy was effective for stimulating an angiogenic-healing response in tendon tissue.<sup>8</sup> Histologic evaluation of treated tendons showed an early inflammatory response, with new blood-vessel formation by 28 days. In 2005, short-term results of this technique were published.<sup>9</sup> This preliminary

**E**lbow epicondylitis is a painful condition caused by overuse and development of tendon degeneration. It is one of the most common elbow problems in adults, occurring both laterally and medially. “Tennis elbow” or lateral epicondylitis is diagnosed 7 to 10 times more often than the medial form, “golfer’s elbow.”<sup>1</sup> Although these injuries are often associated with racquet sports, activities such as bowling and weightlifting and the professions of carpentry, plumbing, and meat-cutting have been described as causes.<sup>2,3</sup>

Elbow epicondylitis is thought to be the result of multiple

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prospective case series showed that the treatment was safe and effectively improved or eliminated clinical symptoms.<sup>9</sup> In the present midterm study, we hypothesized that pain scores would improve after RF microtenotomy and that these favorable results would continue to be observed over a longer term postoperatively.

## Materials and Methods

### Patients

This was a prospective, nonrandomized, single-center clinical study. After receiving institutional review board approval, patients who were 18 to 65 years of age with a diagnosis of tendinosis were approached for enrollment. For inclusion, patients had to be symptomatic for at least 6 months and had to have failed extensive conservative treatments. Nonoperative treatment included activity modification, enrollment in a facility- or home-based exercise program, bracing, oral nonsteroidal anti-inflammatory medication, and cortisone injection. Candidates with diabetes, confirmed or suspected pregnancy, surgery in the same tendon, implanted hardware adjacent to the target treatment region, or who were receiving care under workers' compensation or had litigation-related injury were excluded. A single clinician performed a thorough medical history and clinical evaluation. The clinical follow-up and data collection were performed by an independent medical technician.

### Clinical Outcomes

Pain status was assessed by using a visual analog scale (VAS). Postoperative clinical assessment was conducted within the first 2 days; at 7 to 10 days; at 4 to 6 weeks; and at 3, 6, 12, and 24 months, up to 9 years postoperatively. The VAS scales were completed annually up to 9 years after the procedure.

The percent improvement of VAS score was calculated. This value represented the difference between the patient's preoperative and most recent VAS assessments. Failure of the procedure was defined as less than 50% improvement of the VAS score.

### The RF-Based Microtenotomy Device

The Topaz Microdebrider (ArthroCare), connected to a System 2000 generator at setting 4 (175 V-RMS), was used to perform the RF-based microtenotomy. The device uses a controlled plasma-mediated RF-based process (coblation). Radiofrequency energy is used to excite the electrolytes in a conductive medium, such as a saline solution, to create precisely focused plasma. The energized particles in the plasma have sufficient energy to break molecular bonds,<sup>10,11</sup> excising or dissolving (ie, ablating) soft tissue at relatively low temperatures (typically, 40°-70° C).<sup>12,13</sup> The diameter of the active tip of the Topaz device is 0.8 mm.

### Surgical Procedure

The senior author performed the majority of procedures in this study. Near the end of the series, the senior author's as-

sociate also performed procedures. The symptomatic area of the tendon was identified and marked while the patient was alert. After the patient was positioned appropriately, light sedation was administered. A tourniquet was placed over the treatment limb and inflated to 250 mm Hg. A small incision, approximately 3 cm in length, was made over the marked treatment site to expose the involved tendon. After initiating sterile isotonic saline flow of 1 drop every 1 to 2 seconds from a line connected to the RF system, the tip of the device was placed on the tendon perpendicular to its surface (Figure 1). Using a light touch, it was activated for 500 milliseconds using a timer accessory for the control box. Five to 8 grams of pressure were applied with the device to penetrate the tendon and achieve successful ablation. The RF applications were performed at 5-mm intervals, to create a grid-like pattern on and through-

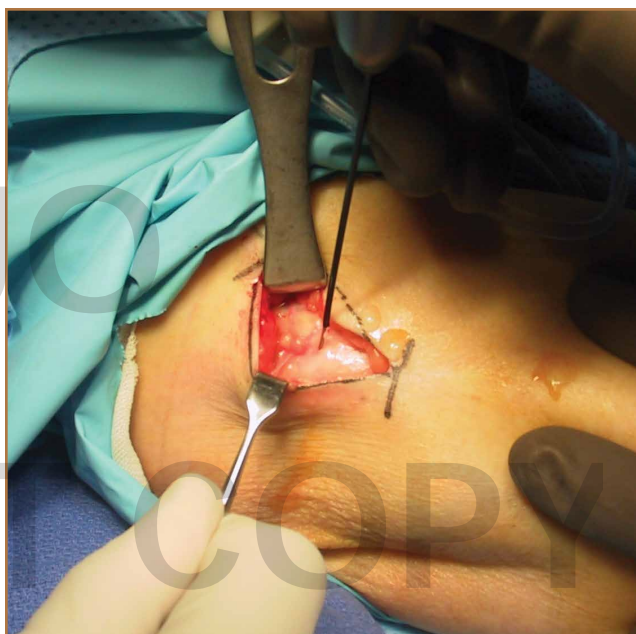


Figure 1. The common extensor tendons of the right elbow undergoing microtenotomy with a Topaz device (ArthroCare).

out the symptomatic tendon area. The tendon was perforated to a depth of several millimeters on every second or third application throughout the treatment grid. After treatment of the symptomatic area, the wound was irrigated with copious amounts of normal saline solution and closed with interrupted nylon suture. Local anesthetic was injected only in the skin and in subcutaneous tissue. Standard wound dressings were applied. In the immediate postoperative period, the patient was advised to begin gentle active and passive range-of-motion exercises. Each patient was evaluated at 1 week postoperatively. At 6 weeks, patients were permitted to increase the intensity of their activities. Return to sports and heavy lifting was allowed once the patient was asymptomatic and had achieved full strength and range of motion; this typically occurred at 6 to 9 weeks after surgery.

## Statistical Analysis

Normally distributed data were described using standard parametric statistics (ie, mean and standard deviation); non-normally distributed data were characterized using nonparametric descriptors (ie, median and quartiles). Statistical evaluation of improvement in pain status was performed by calculating 99% confidence intervals and using the Student t test for change between subsequent time points. Use of confidence intervals provides a descriptive analysis of the observed treatment effect, while permitting determination of statistical relevance. In all statistical testing, confidence bounds not including 0 were considered statistically significant. Probability of  $P \leq .01$  for committing type I experiment-wise error (rejecting a true null hypothesis) was selected for all statistical testing because of our lack of a control group, small sample size, and evaluation of multiple postoperative time points.

## Results

Eighty consecutive patients with tendinosis of the elbow were included in this study. Sixty-nine patients were treated for lateral epicondylitis and 11 for medial epicondylitis. The average age of the patients (33 women, 47 men) was 50 years. The duration of follow-up evaluation ranged from 6 months to 9 years (mean, 2.5 years; median, 2 years). The Table presents the VAS improvement for these patients after the RF microtenotomy.

Within the lateral epicondylitis group, 91% (63/69) of the patients reported a successful outcome. The postoperative VAS improved to 1.3 from 6.9, which demonstrated an 81% improvement. Of the 6 patients that did not improve, 2 underwent repeat surgery.

Among the patients treated for medial epicondylitis, 91% (10/11) reported improvement in symptoms. The postoperative VAS improved to 1.3 from 6.1, a 79% improvement. One patient did not improve and did not undergo repeat surgery.

## Discussion

For the treatment of medial and lateral elbow epicondylitis, RF microtenotomy is successful in 91% of patients. Symptomatic improvement was observed up to 9 years postoperatively. During this study, no complications were recorded; 7 treatment failures occurred. When compared with other techniques, the results with RF microtenotomy are equivalent or better.

In a retrospective study, Szabo and colleagues<sup>14</sup> compared

open, arthroscopic, and percutaneous release for lateral elbow tendinosis. They found the 3 methods to be highly effective for the treatment of tendinosis with no significant difference between them. Resection of the epicondyle and transfer of the anconeus muscle was found to be effective (94%) in a retrospective study by Almquist and colleagues.<sup>15</sup> Dunn and coauthors<sup>16</sup> reported a 97% success rate at 10 to 14 years postoperatively with a mini-open technique. Rubenthaler and colleagues<sup>17</sup> showed 88% effectiveness for the open technique and 93% for the arthroscopic technique. With arthroscopic release of the extensor carpi radialis brevis tendon, Lattermann and coauthors<sup>18</sup> reported clinical improvement in 94% of patients. In a study by Rose and colleagues,<sup>19</sup> denervation of the lateral epicondyle was effective in relieving pain in 80% of patients who had had a positive response to a local anesthetic block. In a recently published study by Koh and coauthors,<sup>20</sup> 19 of 20 patients experienced a favorable outcome after treatment with ultrasonic microresection.

Regardless of surgical methods and their reported success rate, complications are associated with elbow surgery. Postoperative problems may include restricted function, elbow instability, persistent muscle weakness, and painful neuroma of the posterior cutaneous nerve.<sup>10,21,22</sup> The recent introduction of arthroscopic release offers the potential for less morbidity and enables visualization of the elbow joint. However, disadvantages of the arthroscopic approach include violation of the joint for extra-articular pathology, increased operative time and cost, and neurovascular complications. Additionally, it is possible that the entire spectrum of extra-articular tendinosis cannot be effectively identified arthroscopically.<sup>23</sup> In a prospective, randomized study, Meknas and colleagues<sup>24</sup> compared RF microtenotomy with extensor tendon release and repair. They showed that patients treated with RF-microtenotomy experienced earlier pain relief and improved grip strength over the release group.

Different proposed mechanisms of action have been described to explain the favorable effects of the RF-based microtenotomy procedure, such as induced healing by an angiogenic response in the tendon tissue. In an animal study, Harwood and colleagues<sup>8</sup> showed that low-dose RF-based plasma microtenotomy has the ability to stimulate angiogenic growth factors in tendons, such as  $\alpha_v$  integrin and vascular endothelial growth factor. These factors have been shown to be associated with healing.<sup>8</sup> Early inflammatory response with new-vessel formation after 28 days was found in another animal study using the same method.<sup>25</sup> Evaluation of RF-based methods in a prospective controlled laboratory study using a rabbit-tendon model showed histologic evidence of early inflammation with development of neovasculature after treatment.<sup>8</sup> A later histologic study using an aged Achilles rabbit tendon model was performed to evaluate the effect of RF-based plasma microte-

**Table. Subjective Improvement After Radiofrequency Microtenotomy**

VAS Score Improvement (Decrease)	Lateral Epicondylitis	Medial Epicondylitis
	(n = 69)	(n = 11)
Excellent ( $\geq 88\%$ decrease)	52	8
Good (75%-87% decrease)	8	1
Fair (50%-74% decrease)	3	1
Poor (<50% decrease)	6	1

Abbreviation: VAS, visual analog scale.

notomy on collagen remodeling.<sup>25</sup> The degenerated tendon showed gaps, few normal crimpings, and a lack of reflectivity under polarized light. At 9 days after treatment, the treated tendon showed localized irregular crimpings, and, at 30 days, it showed regular crimping, tightly dense collagen fibers, and hypercellularity with good reflectivity. This was similar in appearance to a normal nondegenerated tendon (Figures 2A-2D). The RF-treated tendon also demonstrated an increase in production of insulin-like growth factor-1,  $\beta$ -fibroblast growth factor-1,  $\alpha_v$  integrin, and vascular endothelial growth factor.

Pathologic nerve ingrowth or nerve irritation in the tendon substance has been considered a possible cause of the pain experienced with tendinosis. Radiofrequency treatment has been shown to induce acute degeneration and ablation of sensory nerve fibers.<sup>26</sup> These degenerated nerve fibers were observed to regenerate at 90 days after treatment.<sup>27</sup> These findings provide potential evidence for early pain relief that is maintained long term as the nerves regenerate.

This midterm follow-up of patients with elbow epicondylitis has shown that RF-based microtenotomy can produce successful, durable results. Microtenotomy is a technically simple

procedure to perform and is associated with a rapid and uncomplicated recovery. It is safe and can effectively eliminate or markedly reduce clinical symptoms.

### Limitations

Lateral epicondylitis has been described as a self-limited disease, with resolution of symptoms at 12 to 18 months with conservative treatment. This perspective challenges the indication of any proposed surgical treatment for the condition. Although the results of this research demonstrated the benefits of RF microtenotomy, there are inherent limitations of the study design. The study lacks a control group, and randomization would improve the strength of the study. Additional outcome measures, such as Disabilities of the Arm, Shoulder, and Hand score, and grip strength could complement pain scores to provide more data. These data were collected in a preliminary study.<sup>9</sup> Postoperative histologic analysis of treated human tissue would be ideal, but ethical considerations limit study to animal models. An additional limitation is potential examiner bias. Data collection was performed by an independent medical technician; a third-party blinded evaluation could have been performed, but this was not feasible in a clinical setting.

### Conclusion

Radiofrequency-based microtenotomy is a safe and effective procedure for elbow epicondylitis. The results are durable with successful outcomes observed 9 years after surgery.

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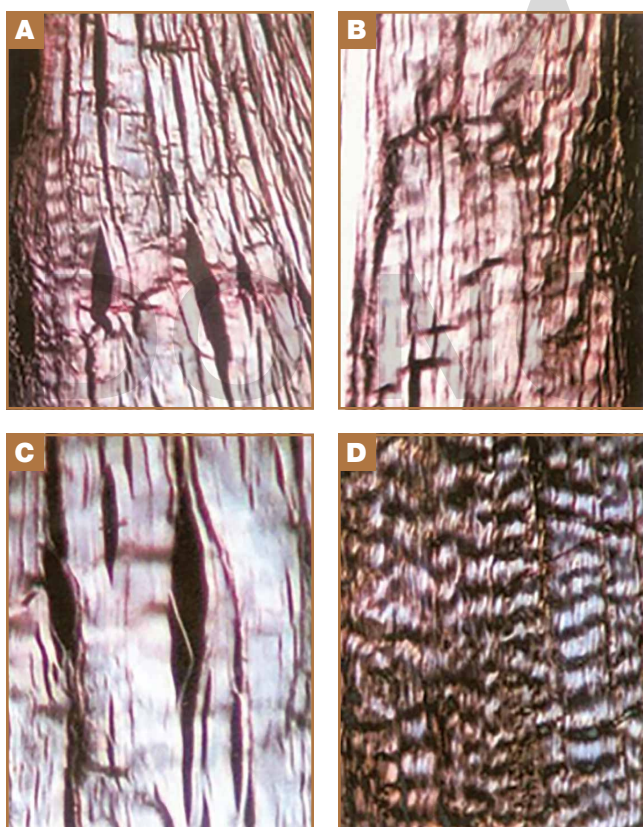
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**Figure 2.** Rabbit Achilles tendon treated with radiofrequency (RF) microtenotomy. (A) At 9 days, control tendon shows less regular crimping and more frequent gaps between collagen bundles. (B) At 9 days, RF-treated tendon shows overall irregular crimping and tightly dense collagen fibers. (C) At 30 days, control tendon shows less regular crimping and more frequent gaps between collagen bundles. (D) At 30 days, RF-treated tendon shows regular crimping, tightly dense collagen fibers, and hypercellularity.

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