Radiofrequency Microtenotomy
A Promising Method for Treatment of Recalcitrant Lateral Epicondylitis

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Abstract

Background: Recalcitrant lateral epicondylitis (elbow tendinosis) is a common cause of elbow pain. There are many forms of treatment, none being superior.

Hypothesis: The main hypothesis tested in this study is that radiofrequency microtenotomy offers better results than the extensor tendon release and repair operation for elbow tendinosis, especially earlier recovery.

Study Design: Randomized controlled trial; Level of evidence, 1.

Methods: Twenty-four patients were randomized into 2 treatment groups, extensor tendon release and repair, and microtenotomy. Dynamic infrared thermography (DIRT) was employed as an objective method to verify the

diagnosis as well as to document the outcome 3 months after the surgical procedure.

Results: Visual analog scale pain scores in the microtenotomy but not in the release group decreased significantly after 3 weeks. There was no statistically significant difference in pain scores between the 2 groups at 3, 6, and 12 weeks, and at 10 to 18 months. At 12 weeks, grip strength had improved significantly in the microtenotomy but not in the release group. The functional score was significantly increased in both groups. The DIRT group showed significant differences in epicondyle skin temperature between diseased and normal elbows both pre- and postoperatively. Abnormal DIRT images correlated well with elevated pain scores.

Conclusions: Radiofrequency microtenotomy provides a promising alternative to the release operation for elbow tendinosis. Dynamic infrared thermography provides a reliable, noninvasive, objective method for the diagnosis of elbow tendinosis, as well as for evaluation of the outcome following treatment.

Keywords:

- tendinosis
- epicondylitis
- microtenotomy
- infrared thermography

Recalcitrant lateral epicondylitis (tennis elbow) is a painful condition affecting the lateral part of the elbow. It is characterized by pain localized over the origin of the extensor carpi radialis brevis (ECRB) and tenderness at the lateral epicondyle; usually the pain is exacerbated by resisted wrist dorsiflexion and forearm supination. The incidence of the disease is about 4 to 7 per 1000 per year in the general population.[3] It is common in the fourth decade of life. A frequent consequence of the disease is absence from work for several weeks, months, or years. In the literature, local injury, aging, overuse, and

hypovascularity have been mentioned as causes of lateral epicondylitis.[12,14,16,20,27] Nirschl and Ashman[16] found angiofibroblastic hyperplasia on the ECRB caused by tendon overuse and failed healing, and they suggested the term angiofibroblastic tendinosis.

The diagnosis is mainly a clinical one. Tenderness on the lateral epicondyle and exacerbation of pain by resisted extension of the wrist with the elbow extended (Thomsen test) suggest involvement of the ECRB and extensor carpi radialis longus (ECRL). The extensor digitorum communis (EDC) can be tested by resisted active extension of the middle finger. A number of conditions may be associated with pain laterally on the elbow, including the posterior interosseus nerve entrapment syndrome, osteochondritis dissecans, varus instability, osteoarthritis, and cervical and shoulder injury.

A routine radiograph is important to rule out alternative lesions such as tumors and osteoarthritis. Radiographs may show calcification in the region of the lateral epicondyle in up to 7% of cases, a finding that does not alter the treatment strategy.[27]

Lateral epicondylitis is a degenerative condition associated with angiofibroplastic hyperplasia.[16] However, many treatment approaches are based on the view that it is an inflammation. Most patients respond to conservative management, and only 5% to 10% of patients need surgery.[4] There are more than 40 methods for the treatment of lateral epicondylitis but no particular one is recognized as being superior.[8,12] Conservative treatments such as rest, nonsteroidal anti-inflammatory drugs (NSAIDs), stretching, splinting, local injection of corticosteroid,[14] and shock wave therapy[13,18] have been reported with variable results. Hayton et al[11] found no significant difference between the results of treatment with botulinum toxin A and placebo, whereas Placzek et al[19] advocated botulinum toxin A injection because they found a significant improvement in the treated compared with the placebo groups. In a recent pilot study, treatment of chronic elbow tendinosis with buffered platelet-rich plasma reduced pain significantly.[15]

Surgical procedures consisting of release of the extensor tendon, epicondylar resection, and excision and debridement of affected tissue have a frequency of good to excellent success rates of up to 90%.[25] Nirschl et al[16,17] reported 83% good to excellent results after excision and repair of angiofibroblastic tissue during surgical exposure of the ECRB. In a recent study, Tasto et al[25] reported

that radiofrequency (RF)–based microtenotomy could be employed as a safe and effective procedure for treatment of chronic tendinosis. However, this was a nonrandomized study involving tendinopathy in the elbow, patellar tendon, and Achilles tendon. Tendinosis is characterized by the presence of fibroblasts, hypovascularity, and collagen disorganization, which leads to healing failure. The treatment goal is to initiate healing by stimulating angiogenic responses. The bipolar RF–based microtenotomy is thought to induce healing by a controlled inflammatory response followed by a stimulation of an angiogenic healing in the tendon.[10] In a histologic evaluation, Tasto et al[25] showed an early inflammatory response with new vessel formation after 28 days. The main aim of the present study was to reassess the RF microtenotomy procedure for treating epicondylitis by comparing it with the release and repair of the extensor tendon.

Dynamic infrared thermography (DIRT) was employed as an objective method to verify the diagnosis of lateral epicondylitis as well as to document the outcome 3 months after the surgical procedure. In patients suffering from epicondylitis, a close correlation between clinical pain symptoms and the presence of a hot spot over the lateral epicondyle has been demonstrated.[2] The normal pattern is that the elbow is colder than surrounding structures.[5,21,26] To our knowledge, DIRT has not been previously used to evaluate the outcome after surgical treatment of epicondylitis.

PATIENTS AND METHODS

This prospective randomized study was approved by the Regional Ethical Committee in northern Norway. A total of 24 patients, 11 women and 13 men, with a positive diagnosis of tendinosis of the lateral epicondyle of the elbow were enrolled. Eight patients in the extensor release and repair group (hereafter referred to as the release group) and 10 patients in the microtenotomy group had physically demanding occupations. The indication for surgery was pain and tenderness in the lateral epicondylar area with exacerbation of pain with resisted extension in the wrist and digits. Minimum symptom duration was 12 months. Fourteen patients (6 in the release group and 8 in the microtenotomy group) were disabled with continuous symptoms. Ten of the patients had variable and intermittent symptoms but were able to perform their occupations even though they suffered from pain. Patients with cancer, severe organic diseases, seriously reduced general health status, or those with an unclear diagnosis with diffuse pain were excluded. The mean age was 49.2 years (range,

36–62) in the release group, and 46.7 years (range, 30–64) in the microtenotomy group. The mean symptom duration in the release group was 27.6 months (range, 12–60), and 22 months (range, 12–50) in the microtenotomy group. The right elbow was affected in 15 patients and the left in 9 patients. Seven patients had bilateral epicondylitis; however, only 1 side was treated in these patients.

All patients had completed at least 1 year of conservative therapy. This included at least 3 injections with corticosteroid drugs that had a short-term effect. All patients used NSAIDs for several weeks without clear improvement. Also, physical therapy had been included in all cases at primary health care institutes over a period of at least 3 months. After the failure of conservative treatment, the patients were considered for surgical intervention.

The diagnosis was confirmed and all operations were performed by a single orthopaedic surgeon (K.M.). Routine radiographic examinations of the affected elbow were carried out in all patients to rule out alternative lesions such as tumors and osteoarthritis. All radiographic examinations were normal.

The operations were carried out as an outpatient procedure using local anesthesia and sedation. Pain was evaluated by a visual analog scale (VAS), grip strength by a dynamometer (Jamar, Sammons Preston Rolyan, Mississauga, Ontario, Canada), and the functional improvement was assessed by Mayo Elbow Performance Score (MEPS) preoperatively and 3, 6, and 12 weeks postoperatively. Before consultation with the examining surgeon, the patients made an evaluation of their VAS score and MEPS. Grip strength was also evaluated during the consultation. Additionally, a telephone interview was carried out 10 to 18 months postoperatively. The patients were randomly selected and divided into 2 groups by share lot on the day of the operation. Eleven patients were operated with extensor tendon release and repair, and 13 patients were operated with microtenotomy using a Topaz Microdebrider electrode (ArthroCare, Austin, Texas).

The extensor tendon release and repair technique used was similar to that described by Nirschl and Pettrone,[17] with a slight modification. First, a long incision approximately 3 to 4 cm was centered slightly distal to the lateral epicondyle and the origin of the common extensor was exposed by dissection. Violation of the joint capsule was avoided. The interval between the ECRL and EDC was identified and widened by a small incision in line with the fibers,

exposing the ECRB deeper and posterior to the ECRL. The proximal origin of ECRB was released from its attachment. In some cases, the EDC was fibrillated and discolored and it was released in a similar manner as the ECRB. The exposed fibrous-like granulation tissue was then removed with a curette or periosteal sleeve. The lateral epicondyle was decorticated. The tendon was repaired by a side-to-side suture technique without tension. The extensor aponeurosis was then closed before wound closure. A soft dressing was applied to the elbow. Pain permitting, postoperative mobilization was encouraged.

For the microtenotomy procedure, an incision of about 3 cm in length was made over the affected epicondyle to expose the involved extensor tendon. The Topaz electrode, which was connected to a sterile isotonic saline flow system, was used for microtenotomy. An RF apparatus provided the energy delivered through the electrode. In carrying out the procedure, the recommendations of ArthroCare for the use of this device were followed. The electrode was placed on the tendon perpendicular to its surface. The routine consisted of performing RF applications on the tendon in a grid-like pattern, where each spot stimulated was placed 5 mm from the neighboring one. Two to 3 light touches were first done, followed by penetration of the tendon to a depth of 3 to 5 mm, depending on tendon thickness, to perform the actual microablation.[25] The activation time for the electrode is fixed by the manufacturer at 0.5 sec. The affected tendon usually required 3 to 6 microablations.

In 18 of the 24 patients, skin surface temperature of the elbows and forearms on both sides were measured preoperatively and 3 months postoperatively by DIRT using a Nikon Laird S270 infrared camera (Nikon, Tokyo, Japan). The infrared camera produces an image of the temperature distribution on the surface of the body. The technique is based on the relationship between dermal perfusion and the rate of change in skin surface temperature after transient thermal challenges.[7,28] Thermal images were taken in a draught-free room kept at a constant temperature of 21° to 22°C. The lateral epicondyle on both arms was marked with a small piece of silver tape to facilitate its localization in the infrared images. An expanded polystyrene sheet was positioned behind the arm to provide a uniform thermal background in the infrared images. The infrared images were stored electronically for later processing using PicWin-IRIS image analysis software (EBS Systemtechnik GmbH, Munich, Germany). After a stabilization period of 10 minutes, the elbow and forearm were subjected to mild convective cooling for a period of 1 minute with the aid of a desktop fan. After the end of cooling, thermal images were taken at 30-second intervals for

4 minutes during the rewarming period. The maximum skin surface temperature was measured 2 minutes into the rewarming period, within a circular region of about 2 cm in diameter, covering the lateral epicondyle in both the normal and the affected elbow.

Statistics

Data are reported as mean values with standard deviation unless otherwise indicated. All statistical analyses were performed using the SPSS version 14.0 software (SPSS Science Inc, Chicago, Illinois). The paired sample *t* test was used for evaluating differences, and *P* values <.05 were considered to indicate significant differences.

RESULTS

Twenty-four patients were enrolled in this study. All patients had received varying forms of conservative treatment without improvement before the operation. The median length of the operation for the release group was 30 minutes (range, 22–40) and 18 minutes for the microtenotomy group (range, 10–23). The immediate preoperative mean pain score (VAS) in the release group was 6.5 (range, 4–8). Mean VAS values 3, 6, and 12 weeks postoperatively had decreased to 6.4 ($P < .2$), 4.0 ($P < .04$), and 3.1 ($P < .001$), respectively (Figure 1). Pain improvement in the microtenotomy but not in the release group was already significant at 3 weeks, with the VAS score being reduced from 7.1 (range, 5–10) preoperatively to 3.6 (range, 0–9) ($P < .05$) postoperatively. Pain was further significantly reduced in the microtenotomy group at 6 weeks (VAS 3.2, $P < .001$) and at 12 weeks (VAS 2.0, $P < .001$). Twenty-three patients evaluated between 10 and 18 months still had significantly reduced pain when compared with preoperative values ($P < .05$). At 10 to 18 months, the VAS score for the microtenotomy and release group was 2.0 (range, 0–7) and 1.8 (range, 0–6), respectively (Figure 1). There was no statistically significant difference in VAS score between the 2 groups at 3, 6, and 12 weeks or at 10 to 18 months.

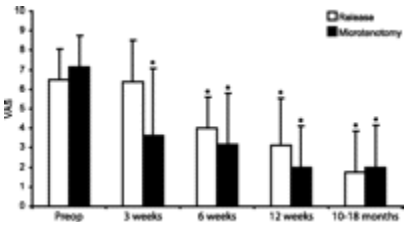

Figure 1.

Pain as reported on a visual analog scale (VAS) preoperatively and at 3, 6, and 12 weeks, and 10 to 18 months postoperatively. The pain reduction was significant at 3 weeks in the radiofrequency microtenotomy but not in the release group. However, at 6 and 12 weeks and 10 to 18 months, the pain reduction was significant in both groups. *Significant difference from respective preoperative value.

The average grip strength as measured by the Jamar dynamometer 12 weeks postoperatively increased from 30.3 to 36.3 kg in the release group (not significant), and from 28.3 kg to 39.8 kg in the microtenotomy group ($P < .001$) (Figure 2). Furthermore, there was no statistically significant difference in grip strength between the 2 groups at 12 weeks. There was no significant difference in grip strength on the contralateral side either within or between the 2 groups, either preoperatively or at 12 weeks postoperatively. The MEPS at 12 weeks improved from 60 to 82.2 points ($P < .01$) in the release group, and in the microtenotomy group the score increased from 55.4 to 87.3 points ($P < .001$) (Figure 3). There was no significant difference in MEPS between the 2 groups either preoperatively or at 12 weeks postoperatively.

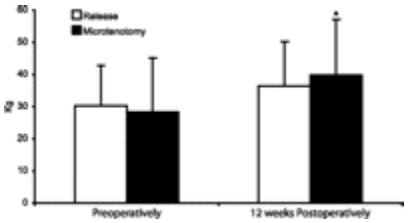

Figure 2.

Grip strength measured preoperatively and at 12 weeks postoperatively with a Jamar dynamometer. Strength had increased significantly in the microtenotomy group but not in the release group when compared with the preoperative values. *Significant difference from respective preoperative value.

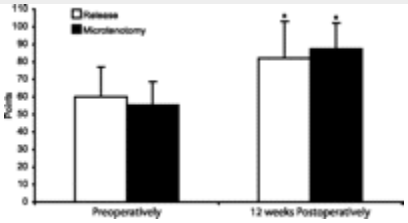

Figure 3.

The Mayo Elbow Performance Score (MEPS) preoperatively and at 12 weeks after operation. There was a significant improvement in the MEPS in both the microtenotomy and in the extensor release group. *Significant difference from respective preoperative value.

There was no statistically significant difference between the 2 groups in the time it took for the patients to return to work. Eight patients returned to work in the release group after a mean sick leave of 11.5 ± 6.3 weeks. Eleven patients from the microtenotomy group returned to work after a mean sick leave time of 10.7 ± 2.5 weeks, while 5 patients continued sick leave because of another disorder or changes in their previous job ($P < .7$). Figure 4 presents examples of preoperative (Figure 4A) and 3-month postoperative (Figure 4B) DIRT images of a patient with epicondylitis in the left elbow. The preoperative image shows a clear hot spot over the left epicondyle, while the hot spot has disappeared postoperatively. Preoperatively, there were statistically significant differences between the mean values of maximum skin temperature of the lateral epicondyle in the affected elbow (32.6° ± 0.2°C) compared with the unaffected elbow (31.9° ± 0.2°C) when the patients with bilateral epicondylitis were excluded. Postoperatively, there were no significant differences between the operated and the control elbows (32.2° ± 0.1°C and 31.9° ± 0.1°C, respectively).

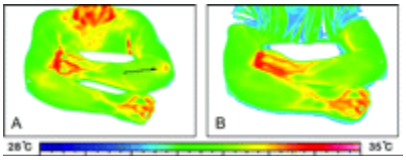

Figure 4.

Preoperative (A) and postoperative (B) infrared thermograms of a male patient with epicondylitis on the left elbow. The black arrow marks a clear hot spot over the lateral epicondyle in image A. In this patient, the visual analog scale score changed from 5 to 1 after the operation.

There was a clear hot spot present over the lateral epicondyle in 14 of the 18 affected elbows preoperatively, while the remaining 4 had a warm spot approximately 2 cm distal to the epicondyle. The relationship between a positive VAS pain evaluation and an abnormal DIRT finding becomes 100% if one also includes these 4 patients. Irrespective of the surgical technique used, the hot spot on the lateral epicondyle had disappeared in 78% of the patients. This finding of a normalized thermal image correlated well with a reduced pain score

(VAS ≤ 1.5). Two patients showed false-positive results; both had bilateral epicondylitis. Postoperatively, 2 patients in the release group and 1 patient in the microtenotomy group had a warm spot over the forearm close to the epicondyle in combination with a high VAS score.

DISCUSSION

In this study, we have compared 2 methods for operating lateral epicondylitis—the extensor tendon release and repair and RF-based microtenotomy. One interesting finding in the RF microtenotomy group was that pain already was reduced at 3 weeks compared with preoperative values ($P < .05$). Such early improvement was not found in the release group. At 6 and 12 weeks, both groups had improved compared with preoperative values (Figure 1). Another interesting finding was that grip strength had improved significantly at 12 weeks in the microtenotomy group but not in the release group. The functional improvement measured by MEPS was also significant in both groups at 12 weeks.

Although VAS scores decreased more rapidly during the first 3 weeks in the microtenotomy group, the pain scores were later similar in both groups up to 10 to 18 months. The rapid improvement in the microtenotomy group may be related to the less invasive approach when compared with the release technique. As described by others, it is difficult to achieve complete pain relief in all patients with operative treatment.[1,16,20,23] Some of the patients also had complaints from additional musculoskeletal diseases.

Preoperatively, the DIRT technique confirmed the abnormal thermal pattern reported in other studies in patients with diagnosed lateral epicondylitis.[5,9] The affected elbows had significantly elevated temperature over the lateral epicondyle compared with the normal elbows. Postoperatively there was a very clear correlation between reduced VAS scores, a positive outcome, and the disappearance of hot spots.

It is interesting that there were 4 patients with an abnormal area of elevated skin temperature (hot spot) located slightly distal to rather than directly over the lateral epicondyle; this was also associated with elevated pain scores (VAS). Thus, an abnormal DIRT image in our patients, irrespective of whether the warm area was directly over the lateral epicondyle or close by, correlated 100% with a positive VAS pain evaluation. However, we are not sure whether the abnormal

thermal images seen in these 4 patients are directly related to epicondylitis as 2 of these patients had unchanged thermal images and maintained high pain scores after surgery.

In the literature, different possible mechanisms have been suggested for the effect of the RF-based microtenotomy procedure, such as induced healing by an angiogenic response in the tendon tissue.[10,25] In an animal study, Harwood et al[10] showed an increase in the expression of the angiogenic markers αv integrin subunit and vascular endothelial growth factor after RF-based microtenotomy, and an early inflammatory response with new vessel formation after 28 days was found in another animal study using the same method.[25] A recent study documenting quick degeneration or ablation of nerve fibers after RF-based microtenotomy may explain the rapid effect of the method.[24] The rapid effect of RF microtenotomy in our study may indicate that local neural ablation was induced. It is also obvious that the RF microtenotomy procedure induces less damage to surrounding tissues during the operation.

In a retrospective study, Szabo et al[23] compared open, arthroscopic, and percutaneous release for lateral elbow tendinosis. They found all 3 methods 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 effective (94%) in a retrospective study by Almquist et al.[1] Arthroscopy has been a promising procedure, but it is technically demanding and associated with complications.[4,20,22] Nirschl and Pettrone[17] reported 85% good to excellent outcomes and Rubenthaler et al[20] showed 88% effectiveness for the open technique and 93% for the arthroscopic technique in the Morrey score. In our randomized, controlled study, VAS score, MEPS score, and grip strength were the methods for evaluating treatment effect. Comparing our study with retrospective studies without clear preoperative values has been problematic. Generally, none of the patients in our study deteriorated, and all improved. The results in our study seem to have a similar success rate when compared with most other reports.

Regardless of the surgical method used and its success rates, there may be a number of complications associated with surgery. Postoperative problems may include restricted function, elbow instability, persistent muscle weakness, and painful neuroma of the posterior cutaneous nerve.[6,16,25] We found no complications with any of the operative methods. Local anesthesia was used

both for the release procedure as well as for the RF microtenotomy, without any observed serious drawback.

Compared with the release procedure, the operation time for microtenotomy is short, and it is simple and safe to perform. There were no complications or adverse effects in the group treated with RF microtenotomy, and we have no serious concerns about the method. We think that microtenotomy is worth considering and studying further as an alternative surgical procedure to extensor tendon release and repair.

CONCLUSION

In this study, similar results were found with 2 operative methods for patients with lateral elbow tendinosis. In the group treated with RF microtenotomy, an earlier improvement in VAS score was seen when compared with the release method. Strength increased in that group and not in the release group. The RF microtenotomy method is safe and offers a good alternative to extensor tendon release and repair for the treatment of lateral elbow tendinosis. It is simple to perform, allows early rehabilitation, and provided rapid pain relief that persisted in this study at 10 to 18 months. This method protects normal tissue and tendon attachment without affecting the anatomy of the tendon. The DIRT images proved to be a valuable additional technique when used preoperatively for diagnosing lateral elbow tendinosis, as well as providing valuable information concerning the outcome of the surgical procedures used in this study. Abnormal DIRT images correlated well with elevated pain scores.

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Footnotes

- No potential conflict of interest declared.
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