2014

Effectiveness of Diathermy in Comparison With Ultrasound or Corticosteroids in Patients With Tendinopathy: A Critically Appraised Topic

Philip A. Szlosek
Old Dominion University

John Taggart
Old Dominion University

Julie M. Cavallario
Old Dominion University, jcavalla@odu.edu

Johanna M. Hoch
Old Dominion University, jhoch@odu.edu

Original Publication Citation

Szlosek, P. A., Taggart, J., Cavallario, J. M., & Hoch, J. M. (2014). Effectiveness of diathermy in comparison with ultrasound or corticosteroids in patients with tendinopathy: A critically appraised topic. *Journal of Sport Rehabilitation, 23*(4), 370-375. doi:10.1123/jsr.2013-0063

Journal of Sport Rehabilitation, 2014, 23, 370-375
http://dx.doi.org/10.1123/JSR.2013-0063

Effectiveness of Diathermy in Comparison With Ultrasound or Corticosteroids in Patients With Tendinopathy: A Critically Appraised Topic

Philip A. Szlosek, John Taggart, Julie M. Cavallario, and Johanna M. Hoch

Clinical Scenario: Many therapeutic modalities have been used to treat the pain and inflammation commonly associated with tendinopathies. One modality that has been used to treat patients with tendinopathies is diathermy. ***Focused Clinical Question:*** Is there evidence to suggest that diathermy is more or equally as effective at reducing pain in patients with tendinopathy when compared with ultrasound or corticosteroid treatments? ***Summary of Search, "Best Evidence" Appraised, and Key Findings:*** The literature was searched for randomized control trials (RCTs) that investigated the effects of diathermy treatments in comparison with ultrasound or corticosteroid treatments on pain in patients with tendinopathy. Three RCTs were selected from the search results and included in this critically appraised topic. ***Clinical Bottom Line:*** There is moderate evidence to support that diathermy is more effective at reducing pain in patients with tendinopathy than ultrasound and equally as effective as corticosteroid treatments. ***Strength of Recommendation:*** There is grade B evidence to support that diathermy is more effective at reducing pain in patients with tendinopathy than ultrasound and equally effective at reducing pain as corticosteroid treatments.

Keywords: hyperthermia, pain, tendonitis

Clinical Scenario

Tendinopathies are common overuse pathologies that affect many people of all ages and activity levels. Many therapeutic modalities have been used to treat the pain and inflammation commonly associated with these conditions to promote the healing process. One such modality that has been used to treat patients with chronic inflammatory conditions such as tendinopathy is diathermy.

Focused Clinical Question

Is there evidence to suggest that diathermy is more or equally as effective at reducing pain in patients with tendinopathy when compared with ultrasound or corticosteroid treatments?

Summary of Search, "Best Evidence" Appraised, and Key Findings

- The literature was searched for randomized control trials (RCTs) that investigated the effects of diathermy treatments in comparison with ultrasound or corticosteroid treatments on pain in patients with tendinopathy.
- The literature search returned 5 possible studies related to the clinical question; 3 RCTs met the inclusion criteria and were included.[1–3]
- Two high-quality RCTs[2,3] and 1 low-quality RCT were included.[1]
- Two studies[1,2] demonstrated that diathermy was more effective at reducing pain than ultrasound, and 1 study[1] demonstrated that diathermy was equally as effective at reducing pain as corticosteroid treatments.

Clinical Bottom Line

There is moderate evidence to support that diathermy is more effective at reducing pain in patients with tendinopathy than ultrasound treatments[1,2] and equally as effective at reducing pain as corticosteroid treatments.[3]

Szlosek and Taggart are with the Post-Professional Athletic Training Program; Cavallario, the Dept of Human Movement Sciences; and Hoch, the School of Physical Therapy and Athletic Training, Old Dominion University, Norfolk, VA. Address author correspondence to Julie Cavallario at Jcavalla@odu.edu.

Strength of Recommendation: There is grade B evidence to support that diathermy is more effective at reducing pain in patients with tendinopathy than ultrasound and equally effective at reducing pain as corticosteroid treatments. The Centre of Evidence-based Medicine recommends a grade of B for level 2 evidence with consistent findings. Although the studies included in this CAT were RCTs, based on the limitations of the studies, as well as the PEDro score for 1 of the RCTs, we believe that a grade of B is more appropriate.

Search Strategy

Terms Used to Guide Search Strategy

- **P**atient/Client group: *patients with tendinopathy* (*tendinitis* or *tendonitis* or *supraspinatus* or *tendon* or *rotator cuff* or *epicondylitis* or *patella* or *Achilles*)
- **I**ntervention: *diathermy* (*hyperthermia*)
- **C**omparison: *ultrasound* OR *corticosteroids*
- **O**utcome: *pain*

Sources of Evidence Searched

- PubMed
- Medline
- Academic Search Premier
- Biomedical Reference Collection
- CINAHL
- Health Technology Assessment

Inclusion and Exclusion Criteria

Inclusion Criteria

- Patients with tendinopathy
- Treated with diathermy compared with ultrasound or corticosteroids
- Human subjects
- Articles in English
- Articles published after the year 2000
- RCT study design

Exclusion Criteria

- Included uninjured participants
- Not available in English
- Studies published before 2000
- Evidence rated lower than level 2 or non-RCT design
- Studies examining calcific tendinopathies

Results of Search

Three relevant studies[1–3] were located and are listed in Table 1 (based on Levels of Evidence, Centre for Evidence-based Medicine, 2009).

Best Evidence

The studies included were identified as the best evidence and selected for inclusion in this CAT (Table 2). These studies were selected because they were RCTs that examined a diathermy intervention compared with an ultrasound[1,2] or corticosteroid[3] intervention and measured pain as a clinical outcome.

Implications for Practice, Education, and Future Research

Diathermy is a thermal modality that uses a microwave power generator to heat tissues at approximately a 4-cm depth while cooling superficial tissues to prevent the likelihood of overheating at lesser tissue depths. A recent review indicated that a 434-MHz wavelength is most effective at deep tissue heating while still maintaining proper skin temperature.[4] The review also reported that diathermy is an effective method of treating tendinopathy due to its ability to increase the tissue temperature to 41°C to 45°C, thus increasing blood flow to the area and promoting the healing process.[4] This is notably different than the use of corticosteroids, which is a minimally invasive procedure that is used to reduce symptoms associated with tendinopathy but has greater potential for long-term side effects such as cutaneous atrophy, depigmentation, and infection.[5] Diathermy also differs from ultrasound, as diathermy is designed to prevent superficial tissue temperature from exceeding 42°C to prevent burns.[4] In addition, ultrasound has an effective treatment area of only 2 to 3 times the size of the transducer, whereas diathermy can effectively heat an area up to 400 cm^2.[6]

Based on our search, there is limited evidence available that compares the effectiveness of diathermy with that of other treatment options for reducing pain and inflammation associated with tendinopathy. In the studies reviewed for the CAT, diathermy treatments were compared with ultrasound treatment,[1,2] exercise protocols,[2] and corticosteroid injection treatment.[3] Both studies by Giombini et al[1,2] compared the effectiveness of diathermy as a treatment for tendinopathy with ultrasound. Those studies revealed that diathermy reduced the participants' pain levels significantly more than the ultrasound treatment.[1,2] In addition to ultrasound, Giombini et al[2] also compared the effectiveness of diathermy

Table 1 Summary of Study Designs of Articles Retrieved

Level of evidence	Study design	Number located	Reference
1b	Randomized controlled trial	2	Giombini et al[2]
			Rabini et al[3]
2b	Randomized controlled trial	1	Giombini et al.[1]

Table 2 Characteristics of Included Studies

	Giombini et al[1]	Giombini et al[2]	Rabini et al[3]
Study design	Randomized controlled trial	Randomized controlled trial	Randomized controlled trial
Participants	44 athletes (33 M, 11 F), mean age of 26 ± 4.56 y, with either patellar or Achilles tendinopathy based on clinical history and physician diagnosis. History of all participants included pain initially with activity and later pain with activities of daily living. Duration from onset of symptoms ranged from 6 to 72 wk. *Exclusion Criteria:* Patients treated with other forms of physical therapy or medication within the last 5 wk, with documented patellofemoral pathology, severe lower-limb malalignment, associated meniscal or capsule-ligamentous injury, calcific tendinopathy, Haglund syndrome, or other systemic diseases involving patellar and Achilles tendinopathies. The patients were block randomized with a computer program into 2 groups. Group 1 (N = 22) had a mean age of 26 ± 3.48 y. Group 2 (N = 22) had a mean age of 26 ± 5.5 y.	37 athletes (29 M, 8 F) with a mean age of 26.7 ± 5.8 y with clinical and ultrasonographic diagnosis of supraspinatus tendinopathy in the dominant shoulder (right in 31 patients, left in 6 patients). All patients had gradual onset of shoulder pain that had impaired their sports activities for 3–6 mo before entering the study. All patients were involved in sports at either the county, regional, national, or international level and participated in training at least 3 times a wk. Patients were asked to abstain from movement that caused pain during the treatment but performed modified training. All patients were secondary or tertiary referrals to specialized sports physicians or orthopedic surgeons. All patients completed nonoperative management including rest and nonsteroidal anti-inflammatory drugs. Patients were included if they met all 3 of the following conditions: (1) impingement with a positive Hawkins sign in internal rotation or impingement in 90° of forward flexion with forced external rotation, (2) pain with supraspinatus muscle testing in the "empty can" position, and (3) ultrasonographic evidence of nonhomogeneous signal intensity without a frank tear in the supraspinatus tendon. *Exclusion Criteria:* Patients lacking full passive range of motion in the affected shoulder, with tendinopathy as a result of a single traumatic episode, severe neck pain, frozen shoulder, calcific tendinopathy, or degenerative joint disease of the acromioclavicular or glenohumeral (GH) joint, athletes who had received an intra-articular or subacromial injection of corticosteroids, patients with diagnosed rotator-cuff tear, and those with previous surgery on either shoulder. Patients were randomly assigned into 3 groups using a computer-generated group assignment. Group 1 (n = 14; 12 M) had a mean age 25.3 ± 4.8 y, group 2 (n = 12; 8 M) had a mean age of 28.6 ± 6.6 y, and group 3 (n = 11; 9 M) had mean age of 26.3 ± 6.2 y.	92 men and women age 18 y or older with mean ages of 56.6 ± 11.6 y (corticosteroid group) and 59.2 ± 7.1 y (diathermy group). Must have had shoulder pain lasting for at least 3 mo. Diagnosis of rotator-cuff tendinopathy was established by clinical examination and X-ray. *Inclusion Criteria:* Patients with degenerative rotator-cuff tendinopathy, with or without partial-thickness tendon tears. *Exclusion Criteria:* Inability or unwillingness to sign informed consent, full-thickness tear of the rotator cuff and/or of the subscapularis tendon, degenerative arthritis of the GH joint, symptomatic arthritis of the acromioclavicular joint, previous surgery on the affected shoulder, inflammatory or neurological diseases involving shoulder girdles, anticoagulant treatment, chronic nonsteroidal anti-inflammatory drugs or steroid treatment, cognitive or psychiatric disorders, pregnancy or breastfeeding, or previous treatment with 1 of the 2 interventions. Patients with contraindications to corticosteroid injections, hyperthermia, cancer in prior 2 y or active cancer treatment, local thrombosis, impaired arterial circulation, altered cutaneous thermal sensitivity, local infections or systemic acute infections, metal implants or prosthesis, severe osteoporosis, indwelling electronic devices, or MRI were also excluded. Patients were randomly assigned to either local corticosteroid injections or hyperthermia using a random-sequence generator. Patients were followed up 1, 3, and 6 mo. The corticosteroid group (n = 15 M, 31 F) had a mean age of 56.6 ± 11.6 y; the hyperthermia group (n = 16 M, 30 F) had a mean age of 59.2 ± 7.1 y.

(continued)

Table 2 *(continued)*

	Giombini et al[1]	Giombini et al[2]	Rabini et al[3]
Intervention investigated	Group 1 was treated with hyperthermia at 434 MHz for 12 treatments given 3 times a wk for 4 wk for 30 min per treatment session. Hyperthermia was delivered orthogonal to the electromagnetic field and at the greatest point of tenderness at 20–25 W. The pilot temperature was 42°C with a water bolus temperature in a range of 39–40°C. Threshold of thermal pain was never exceeded in any patient receiving hyperthermia treatment. Group 2 was treated with ultrasound for 12 treatments given 3 times a wk for 4 wk for 15 min per treatment session. Continuous ultrasound therapy was applied in a circular fashion using an emission probe of 3.2-MHz frequency at an intensity of 1.5 W/cm^2. No other ultrasound parameters were provided.	Group A was treated with hyperthermia at 434 MHz over 12 treatment sessions given 3 times a wk for 4 wk for 30 min per treatment session. Hyperthermia was delivered at a power of 50–70 W, with a pilot temperature on the skin of 38–40°C and a water pad temperature of 35–37°C. The thermocouple was placed perpendicular to the electromagnetic field on the shoulder with patient supine with arm at 60° of abduction and externally rotated. Group B was treated with ultrasound therapy for 12 treatment sessions given 3 times a wk for 4 wk for 15 min per treatment session. Ultrasound was delivered at 1 MHz at an intensity of 2.0 W/cm^2 in the same position as group 1. Application was in a slow-moving circular fashion. Group C received no instrumented physical therapy. They were taught exercises consisting of pendulum swings and passive GH-joint stretching exercises to tolerance. All patients were asked to keep a treatment diary that was monitored by a rehabilitation specialist.	The hyperthermia group was treated with 434 MHz by a physiotherapist for a total of 12 treatment sessions (3 sessions a wk for 4 wk), each lasting 30 min. Output power of 40 W was used and a silicone pad water temperature of 38°C. The skin pilot temperature was set to a value aimed at achieving a 1.5°C difference between cutaneous and deep temperature. There was a total radiating area of 240 cm^2 and an effective field size (50% specific absorption rate) on a surface of 96 cm^2. The corticosteroid group underwent 3 local injections (1 injection every 2 wk) of 1 mL 40 mg methylprednisolone acetate containing 10 mg lidocaine chlorhydrate. Injections were performed by a physician at the subacromial space of the affected shoulder using a 21-gauge needle in aseptic conditions, through a posterolateral access. During the time between the start of treatment and the 24-wk follow-up, patients were required to refrain from any additional pharmacological or physical treatment for pain management.
Outcome measures	All patients underwent a clinical and instrumental evaluation before treatment, at the end of the treatment, and 1 mo after the end of the treatment. Subjective pain during local manual pressure at the site of greatest tenderness and during maximum isometric contraction against resistance were measured with a 10-cm horizontal visual analog scale (VAS; 0 = *no pain,* 10 = *incredibly severe pain*). The average of 3 ratings was taken. An ultrasonic evaluation using a linear-array transducer at 7.5 MHz was performed on all patients by the same radiologist to detect abnormalities in the tendons. At the end of treatment patients rated their results as excellent (pain relieved with full return to preinjury level), good (full return, but occasional discomfort), fair (discomfort and resulting reduction in training and competitive activity), or poor (discontinuation of activity and continued pain with activities of daily life).	All patients were assessed at baseline, immediately after the end of the treatment period, and 6 wk after the conclusion of treatment. The following clinical measures were assessed: (1) mean pain score based on a 10-cm horizontal VAS (0 = *no pain,* 10 = *incredibly severe pain*) at night, with movement, and at rest; (2) pain with resisted movement on a 4-point scale (0 = *no pain,* 3 = *severe pain* and inability to exert any strength against minimal manual resistance) assessed with resisted abduction in the neutral position, resisted abduction in external rotation, and resisted abduction in internal rotation; (3) painful arc on active abduction between 40° and 120° on a 4-point scale (0 = *no pain,* 3 = *unable to actively overcome the painful arc*); and (4) the 100-point Constant-Murley score used as an overall assessment of the shoulder during activities of daily life.	All outcomes were evaluated before treatment and at 4, 12, and 24 wk after the completion of each intervention for all outcomes considered by an investigator blind to participants' allocation. The primary outcome measure was the QuickDASH. A secondary outcome was the Constant-Murley shoulder-outcome score. Another secondary outcome was a VAS for pain assessment. Patients were asked to mark the point on a 100-mm line corresponding to the perceived pain intensity, with 0 indicating the absence of pain and 100 representing the most severe pain.

(continued)

Table 2 *(continued)*

	Giombini et al[1]	Giombini et al[2]	Rabini et al[3]
Main findings	Both the ultrasound and hyperthermia groups had reduced VAS scores for pain pressure and pain on active contraction. Hyperthermia resulted in a better effect of the reduction of the VAS scores for both pain with pressure and pain during active contraction than did ultrasound. Hyperthermia resulted in a significantly better global result, with 77% of hyperthermia cases rating the results of the treatment as either good or excellent, while only 33% of ultrasound treatments rated the same.	Patients in group A (hyperthermia) experienced significantly better pain relief than those in either group B (ultrasound) or group C (stretching). The Constant-Murley scale showed significant improvement in group A between the preintervention and follow-up time periods as compared with group B and group C.	The 2 groups did not differ with respect to age, gender, dominant side affected, or symptom duration. Furthermore, baseline values of all outcome measures were comparable between the 2 groups. Analyses revealed that both treatment groups experienced improvements in disability, shoulder function, and pain compared with baseline, with no differences over time between interventions.
Level of evidence	2b	1b	1b
Validity score	PEDro 5/10	PEDro 8/10	PEDro 7/10
Conclusion	The use of hyperthermia at 434 MHz in the treatment of chronic tendinopathies demonstrates a significant reduction in pain and symptoms as compared with ultrasound.	The use of hyperthermia at 434 MHz in the treatment of supraspinatus tendinopathy is effective at reducing pain.	Local hyperthermia and subacromial corticosteroid injections improved shoulder function and pain, and there were no differences between the 2 treatments.

Abbreviations: M, male; F, female.

as a treatment for tendinopathy with an exercise-only group. That study found that diathermy reduced the participants' pain levels significantly more than the exercise treatment. The study by Rabini et al[3] revealed there were no significant differences between treatment groups; both the diathermy treatment and corticosteroid treatment significantly improved shoulder function and pain relative to the participants' baseline scores. Other results indicated that there were no significant differences in QuickDASH scores or Constant-Murley Score for the participants when comparing diathermy with corticosteroids in the treatment of rotator-cuff tendinopathy.[3] The summary of these results would indicate that diathermy is significantly better at reducing pain than ultrasound treatments[1,2] and equally as effective at reducing pain levels as a corticosteroid injection.[3]

Although the studies show statistically significant results, there are differences between the studies that must be noted. The Giombini et al 2002 study[1] analyzed the effect of the 2 modalities on patients with Achilles or patellar tendinopathy, whereas the Giombini et al 2006 study[2] included patients with supraspinatus tendinopathy. Because the tendons vary in length, diameter, and location, it may not be appropriate to assume that the results are related or that the modalities would be as effective on other tendons throughout the body. There was also a difference in ultrasound parameters between the 2 studies.[1] In the 2002 study, researchers used a frequency of 3.2 MHz, and in the 2006 study, researchers used a 2.0-MHz frequency. The frequency of an ultrasound treatment is inversely related to the depth of penetration of the sound waves. Therefore, a frequency of 3 MHz will penetrate the targeted tissue much more superficially than a frequency of 1 MHz The variation of ultrasound parameters does make it challenging to compare results across the studies. Finally, there were age differences for the participants who were included in these studies. The subjects who participated in the Rabini[3] study were older than those in either of the Giombini[1,2] studies (Table 2), therefore potentially making direct comparisons with a young, athletic population more difficult.

We conclude that a level B recommendation can be made that diathermy is more effective at reducing pain in patients with tendinopathy than ultrasound treatments and equally effective as corticosteroid treatments. This level of recommendation was made because all of the studies appraised were RCTs of level 2 evidence or higher with consistent findings. Based on the limitations of 1 of the studies, as well as the PEDro score for 1 of the RCTs, we believe that a grade B is appropriate. While the results of this CAT demonstrate that diathermy is a treatment option for patients with tendinopathy, we believe that it is crucial to continue to use other methods of rehabilitation including stretching and therapeutic exercise to properly restore range of motion or strength for these patients.

Future research is needed to investigate the effects of diathermy on other clinical outcomes associated with tendinopathy, including gains in range of motion and muscle strength in addition to pain levels. Future researchers should also analyze the effects of diathermy on a focused patient population or more specific tendinopathy and include long-term prospective studies with a larger subject pool. In addition, future research should determine the appropriate ultrasound parameter based on desired depth of penetration to allow for better comparison of results. Finally, future studies should address the blinding of patients and treating clinicians in their methodology to strengthen the resulting outcome recommendations. This CAT should be reviewed in 2 years or when additional best evidence becomes available to determine whether additional information has been published that may change the clinical bottom line for the research question posed in this review.

References

1. Giombini A, Di Cesare A, Casciello G, Sorrenti G, Dragoni S, Gabriele P. Hyperthermia at 434 MHz in the treatment of overuse sport tendinopathies: a randomised controlled clinical trial. *Int J Sports Med*. 2002;23:207–211. PubMed doi:10.1055/s-2002-23180
2. Giombini A, Di Cesare A, Safran MR, Ciatti R, Maffulli N. Short-term effectiveness of hyperthermia supraspinatus tendinopathy in athletes: a short-term randomized controlled study. *Am J Sports Med*. 2006;34(8):1247–1253. PubMed doi:10.1177/0363546506287827
3. Rabini A, Piazzini DB, Bertolini C, et al. Effects of local microwave diathermy on shoulder pain and function in patients with rotator cuff tendinopathy in comparison to subacromial corticosteroid injections: a single-blind randomized trial. *J Orthop Sports Phys Ther*. 2012;42(4):363–370. PubMed doi:10.2519/jospt.2012.3787
4. Giombini A, Giovannini V, Di Cesare A, et al. Hyperthermia induced by microwave diathermy in the management of muscle and tendon injuries. *Br Med Bull*. 2007;83:379–396. PubMed doi:10.1093/bmb/ldm020
5. Habib GS, Saliba W, Nashashibi M. Local effects of intra-articular corticosteroids. *Clin Rheumatol*. 2010;29:347–356. PubMed doi:10.1007/s10067-009-1357-y
6. Johns LD, Straub SJ, Howard SM. Variability in effective radiating area and output power of new ultrasound transducers at 3MHz. *J Athl Train*. 2007;42(1):22–28. PubMed