Acta Scientific Orthopaedics (ISSN: 2581-8635)

Volume 6 Issue 8 August 2023

Research Article

The Effectiveness of Thermal Mode of 448 kHz Capacitive Resistive Monopolar Radiofrequency in the Continuous Wave in Patients with Chronic Lateral Elbow Tendinopathy. A Pilot Clinical Trial

Efstratia Giannikou, Tatiana Adamak, Amalia Maria Kallianioti, Kontozoudaki Antonia and Dimitrios Stasinopoulos*

Department of Physical Therapy, University of West Attica: Agiou Spyridonos, Athens, Greece

***Corresponding Author:** Dimitrios Stasinopoulos, Department of Physical Therapy, University of West Attica: Agiou Spyridonos, Athens, Greece.

DOI: 10.31080/ASOR.2023.06.0798

Received: May 31, 2023

Published: July 21, 2023

Abstract

The aim of the present clinical trial was to compare the clinical results of the use of an exercise program with those of an exercise program and thermal (thermia or hyperthermia) mode of 448 kHz Capacitive Resistive Monopolar Radiofrequency in the continuous wave in patients with chronic lateral elbow tendinopathy. Patients were allocated to two groups. Pain, function, strength, and kinesiophobia were measured. An exercise programme and thermal (thermia or hyperthermia) mode of 448 kHz Capacitive Resistive Monopolar Radiofrequency in continuous wave, had reduced the pain and kinisiophobia and improved function and strength in patients with chronic lateral elbow tendinopathy at the end of the treatment and at the follow-ups. Future well-designed randomised controlled clinical trials are needed to establish the effectiveness 448 kHz Capacitive Resistive Monopolar Radiofrequency in the management of chronic lateral elbow tendinopathy.

Keywords: Lateral Elbow Tendinopathy; Exercise; Capacitive Resistive Monopolar Radiofrequency 448kHz

Introduction

Lateral elbow tendinopathy (LET) is the most common chronic disease affecting the elbow joint [1]. Almost 40% of the population will exhibit pain in the lateral epicondyle of the dominant arm at least once in their lifetime [2,3]. Most of these people tend to work in physically laborious jobs carrying out repeated movements with or under great force and vibrations; adopting awkward position [2,3]. LET affects 1-3% of the general population [2,4]. LET is positively correlated with age, it ranges between 35 to 60 years old [4,5]; uses to be manifest mainly at 40 years old [4,6,7]. It can be defined as chronic when the symptoms persist over 4 weeks [6,8-11].

Dealing with LET is imperative, since the number of patients is constantly rising. Physiotherapy is one of the most frequent interventions [12]. There are numerous therapy suggestions [1,13], such as braces, non-steroidal anti-inflammatory drugs (NSAIDs), corticosteroid injections, autologous blood injections, platelet-rich plasma injections (PRP), extracorporeal shock-wave therapy (ECSW), low-level laser therapy (LLLT), acupuncture, cryotherapy, thermotherapy [14-16], which comes in accordance with the complexity of the disease [1]. Systematic reviews do not agree on which treatment approach is the safest and best [14,15] or even whether physiotherapy itself is the ideal intervention [16].

A supervised exercise program is one of the first choices of a physiotherapy program for the conservative treatment of LET without it being the gold standard of dealing with the disease [17]. It is recommended to be combined with another intervention to achieve maximum effectiveness and reduced therapy time [17]. However, the best combination has yet to be discovered [11,17].

Although an exercise program is an effective treatment approach, a supplement to the exercise program should be found to reduce the treatment period [18-23]. One such modality is 448 kHz Capacitive Resistive Monopolar Radiofrequency (CRMRF) which is a relatively new treatment approach, but it is reported to be used by clinicians worldwide. A previous pilot trial showed that the thermal (thermia or hyperthermia) mode of 448 kHz CRMRF in continuous wave, had reduced the pain and improved function and strength in patients with chronic LET at the end of the treatment and at the follow-ups [21]. To our knowledge, there have been no studies to investigate the effectiveness of the thermal (thermia or hyperthermia) mode of 448 kHz CRMRF in continuous wave as a supplement to an exercise program in the management of chronic LET. Therefore, the aim of the present study was to compare the clinical results of the use of an exercise program with those of an exercise program and thermal (thermia or hyperthermia) mode of 448 kHz CRMRF in continuous wave in patients with chronic LET.

Participants and Methods

Twenty patients participated in the trial. Inclusion and exclusion criteria were set according to Stasinopoulos protocol [9-11,24]. This trial was a double-blind pilot RCT. Informed written consent was ensured prior to the assessment, along with a general health and medical history form. Sessions took place in the Laboratory of Neuromuscular and Cardiovascular Study of Motion (LANECASM) of West Attica University. This trial was approved by the Bioethics Committee of the West Attica University (15/10/2021- 86886).

Patients were divided into two groups. Both groups received a supervised exercise protocol total of twenty sessions (5 per week). Group A received 448kHz CRMRF with a continuous standard wave; Application parameters were determined by the manufacturer, INDIBA© (Indiba S.A., Barcelona, Spain).

CAP electrode was applied for 5' on biceps brachii, triceps brachii, and wrist extensors. RES electrode was applied for 10' on the affected area. Lastly, CAP electrode was applied for 5'. The return electrode was placed under the subject's elbow.

The exercise protocol consisted of 3 sets of 15 repetitions of slow progressive exercises of the wrist extensors at each treatment, with a minute rest interval between each set [11,23]; static stretching exercises of the wrist extensors- 3 times before and 3 times after the exercises, lasting 30-45'' 25-28 with a 30-second rest interval between each repetition [28]; 2 sets of 12 repetitions of the scapular and rotator cuff muscle [10,11,29], upper trapezius, rhomboids, serratus anterior, levator scapulae [10,11,17,23,30] and supinator [31].

Wrist extensors were strengthened using the pattern isometric (10'') [32,33]- eccentric - concentric contraction [10,11,23], which was ensured by the use of a metronome application on a portable device (Metronome Beats, Stonekick; 6 beats per minute) [11,23]. The elbow was extended on the therapy surface [11,23]. Participants were informed to continue the exercise even if their pain was mild (<4 on VAS). However, they were informed to stop the exercise if it became disabling (>8 on VAS) [8,9]. When participants were able to carry out the exercise program without experiencing any discomfort or pain, free weights were used to increase the load [11].

All patients were instructed to use their arm as they normally would during the course of the study avoiding activities, however, that would irritate the elbow such as knitting, lifting, driving a car, using a screwdriver, grasping, and handwriting [11]. They were informed to refrain from taking painkiller drugs or other conservative treatment throughout the course of the study [11]. Finally, communication and interaction (verbal and non-verbal) between the therapist and patient were kept to a minimum [11,17,34].

Each patient was evaluated at the baseline (week 0), at the end of treatment (week 4), one month (week 8), and two months (week 12) after the end of treatment in order to see the intermediate effects of the treatments.

Participants were assessed on pain (VAS [35,36], PRTEE – Greek [37,38], function (VAS [35,36], PRTEE- Greek [37,38], Jamar© hand dynamometer [39,40], strength (Jamar© hand dynamometer - pain-free grip strength [39,40] and kinesiophobia (Tampa Scale – Greek [41-44].

SPSS (version 27.0) was used for statistical analyses. The Kolmogorov- Smirnov test was used to test the sample distribution. Paired sample t-test was performed to identify statistically significant side-to-side differences (within the group) for samples that followed a normal distribution and the Wilcoxon test for samples that did not follow a normal distribution. Independent t-test and Mann- Whitney test were performed to analyze the mean comparison of the two groups for samples that followed normal distribution or not, accordingly. P values <0.05 were considered to be statistically significant.

Results

At baseline there were more men than women in the study groups (three more in total). The mean age of the patients was about 47y, and the duration of LET was about 6 months. LET was in the dominant arm in 80% of patients. There were no significant differences in mean age ($p > 0.0005$ by independent t-test) or the mean duration of symptoms ($p > 0.0005$ on independent t-test) between the groups. The patients had received drug therapy as previous treatment. All patients were manual workers.

Baseline VAS was 8.45 (95% CI 8.23-8.89) for the entire sample. There were no significant differences between the groups for baseline VAS ($p>0.05$ on independent t-test) At week 4, there was a decline in VAS of about 6.8 units in the exercise programme and thermal (thermia or hyperthermia) of 448 kHz CRMRF in continuous wave group and 5.4 units in the exercise programme group compared with the baseline ($p < 0.0005$, paired t test). There were significant differences in the magnitude of reduction between the groups at weeks 8 and 12 ($p > 0.0005$ independent t test) (Figure 1).

Baseline PTREE was 86.6 (95% CI 83,4-89,5) for the entire sample. There were no significant differences between the groups for baseline PTREE ($p > 0.05$ on independent t-test) At week 4,

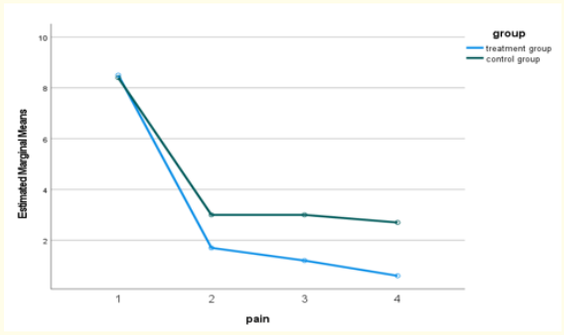

Figure 1: Pain change during assessments.
Treatment group: Exercise programme and 448 kHz CRMRF in continuous.
Control group: Exercise programme.

there was a decline in PTREE of about 77.7 units in the exercise programme and thermal (thermia or hyperthermia) of 448 kHz CRMRF in continuous wave group and 74.7 units in the exercise programme group compared with the baseline ($p < 0.0005$, paired t test). There were significant differences in the magnitude of reduction between the groups at weeks 8 and 12 ($p > 0.0005$ independent t test) (Figure 2).

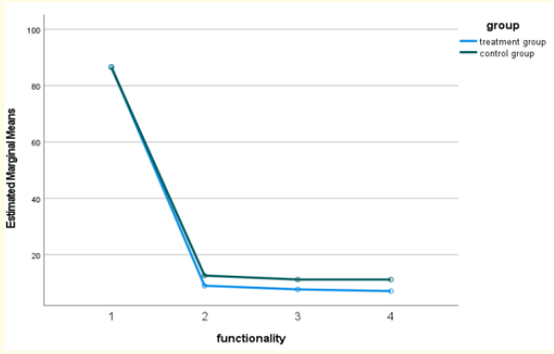

Figure 2: Functionality change during assessments.
Treatment group: Exercise programme and 448 kHz CRMRF in continuous.
Control group: Exercise programme.

Baseline Strength was 22.5 (95% CI 19,78-24,8) for the entire sample. There were no significant differences between the groups for baseline strength ($p > 0.05$ on independent t-test) At week 4, there was an increase in strength of about 40.5 units in the exercise programme and thermal (thermia or hyperthermia) of 448 kHz CRMRF in continuous wave group and 34.9 units in the exercise programme group compared with the baseline ($p < 0.0005$, paired t test). There were significant differences in the magnitude of reduction between the groups at weeks 8 and 12 ($p > 0.0005$ independent t test) (Figure 3).

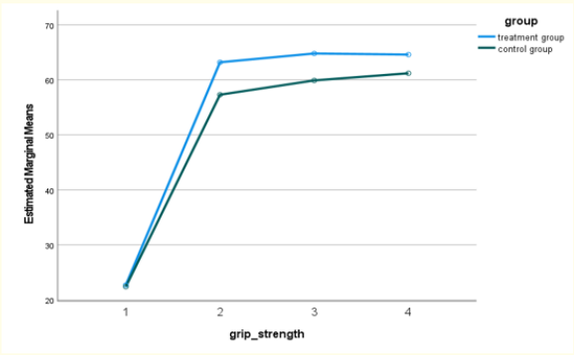

Figure 3: Strength change during assessments.
Treatment group: Exercise programme and 448 kHz CRMRF in continuous.
Control group: Exercise program.

Baseline Kinesiophobia was 55.1 (95% CI 52.4-58.3) for the entire sample. There were no significant differences between the groups for baseline strength ($p > 0.05$ on independent t-test) At week 4, there was a decline in kinesiophobia of about 33.6 units in the exercise programme and thermal (thermia or hyperthermia) of 448 kHz CRMRF in continuous wave group and 31.1 units in the exercise programme group compared with the baseline ($p < 0.0005$, paired t test). There were significant differences in the magnitude of reduction between the groups at weeks 8 and 12 ($p > 0.0005$ independent t test) (Figure 4).

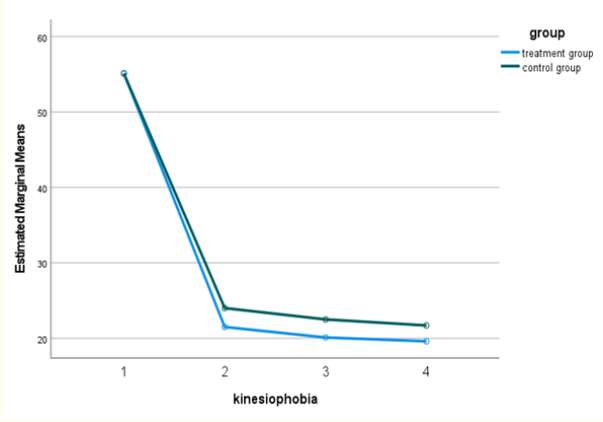

Figure 4: Kinesiophobia change during assessments.
Treatment group: Exercise programme and 448 kHz CRMRF in continuous.
Control group: Exercise programme.

Discussion

The results obtained from this controlled pilot clinical trial are novel; as to date, there have been no data comparing the effectiveness of an exercise programme and thermal (thermia or hyperthermia) of 448 kHz CRMRF in continuous wave and an exercise

programme and placebo 448 kHz CRMRF for the reduction of pain and improvement of function and strength in chronic LET. The exercise programme and thermal (thermia or hyperthermia) of 448 kHz CRMRF in continuous wave produced the largest effect at the end of the treatment and at the follow ups.

INDIBA© CT8 produces radiofrequency in different modes, with standard and modulated waves. When the wave is modulated, there is a reduction of voltage and increase of electric charge. However, the thermal charge is automatically defined by the device at 40% maximum. According to the manufacturer the results are the same, however, our results prove otherwise, so we assume it is the reduction of the voltage that reflects on a lesser thermal effect. In clinical practice, this is hard to be proven, since research in labs has been conducted on animals that have different thermoregulation [18]. It is undoubted though, that there is a difference between SWT (Short Wave Therapy) and 448kHz CRMRF, since, despite the fact that they use the same technology, there is no loss of heat due to the energy transfer through the coupling medium and the different operating frequency (448kHz vs. 27,12MHz) [11,17,18,20-22].

The main effect of 448kHz CRMRF is tissue hyperthermia superficially and deeply. Heat increases metabolic rates, vasodilation and blood flow promoting tissue recovery and providing pain relief by increasing the pain threshold [46]. Hence, Piponas and Stasinopoulos [22] and Stasinopoulos [23] used it to treat acute musculoskeletal conditions. As a matter of fact, tendons in LET do not present inflammation; however, adjacent tissues may be inflammatory [18,19]. Fousekis., *et al.* (2020) found that 448kHz CRMRF increased the temperature of quadriceps skin [10],6% for 164' after the session [19].

Research data for this kind of radiofrequency is really limited, since it has mainly been examined on animals and healthy population [18,20,21]. Musculoskeletal conditions that have been examined and had statistically significant results are knee osteoarthritis [47], acute ankle sprain [22], rotator cuff tendinopathy [20,21], acute LET [23]. Avendano-Coy., *et al.* examined sub-acromial pain and did not find statistical differences on pain and functionality [48].

In this trial, CRMRF was used according to manufacturer's guidelines. However, in clinical practice, the last part of capacitive electrode in non-thermal mode is omitted [18,19]. However, it is supposed to have a draining role and the protocol: CAP RES CAP, should be followed to promote ion mobilization to the return electrode. 448kHz CRMRF is a dose response therapy [20,21]; however, each person perceives temperature differently, since temperature receptors are sensitized from 30-35oC, which is quite a range [49].

There are various protocols, but the ones that prevail come from Pienimaki., *et al.* [50]; Vicenzino [51-53]; Solveborn [54-56]. However, in this trial, the Stasinopoulos protocol was followed; under supervision, with isometric-eccentric [1,67] concentric exercises, strengthening of arm and shoulder, scapula and supinator and static stretches [10,17,27,28]. Under supervision protocols present better results faster [17,28,58-60]. Exercise, according to Karanasios., *et al*, seems to be the best intervention amongst others; however, certainty degree is low [61]. Isometric- eccentric- concentric contraction was used [57] since, the earlier the isometrics begin the better and more long-term the results are [32]; and eccentrics present the most beneficial effect when combined with other interventions [60,62,63].

Exercise was done by the sounds of metronome. This affects neuroplasticity [11,64-66], the relationship between pain and changes in motor control. Tendon neuroplastic training; TNT, affects the central sensitization that occurs in chronic pain [67]. Shoulder and scapula and supinator muscle strengthening was done because muscle weakness affects the joint mechanism and stability [29-31,68].

According to Raman., *et al*, there is great heterogeneity in studies concerning the number of sets, repetitions, time break, frequency and duration [62]. This trial comes in accordance to Chen and Baker's systematic review for eccentric exercise; they concluded that the exercise for LET should be of high dose, once a day, 3 sets, [10-15] repetitions [60].

The duration differs; 4 vs. 6 weeks; but it has been tested as effective [9,28,59]. Patients continued the exercise if their pain was 4 to 8/10 (point where they ceased exercise) on VAS scale to avoid central sensitization, due to fear of pain [46] and the low risk of reinjury, due to self-check [28,60]. However, pain is a psychophysiological behavior unique for each person (George Engel's model) [69].

Participants were instructed to avoid heavy activities during the course of the trial, however, we cannot be sure whether this was followed [11,34]. Communication between participants and therapist was kept to minimum [11], to avoid. Hawthorne effect, however, that is a variable that cannot be fully controlled since physiotherapy demands physical contact and involves the deep relationship between movement, perception, and action [70].

Assessments were conducted three months after the trial, so only the intermediate effect of the therapy was evaluated. It is recommended that future studies should focus on long-term results, as well. The PRTEE questionnaire, according to Bateman., *et al*, is the

ultimate tool for assessing functionality in LET and should be used in every future study [71]. Handgrip strength should also be part of LET assessments. JAMAR® Hydraulic Hand Dynamometer used by this trial is the gold standard for measuring hand-grip strength [71,72]. Another novelty of this trial is the use of the TSK scale. To our knowledge, no other study in Europe has used kinesiophobia as a variable. Persisting pain can cause changes in behavior for both because of physical and psychological reasons [73]. Various psychological factors, such as pain, depression, anxiety, katastrophology, affect pain and functionality [74,75]. In addition to that, hypervigilance to stimuli can cause increase of dysfunction, avoidance of limb use and depression [76]. In this trial, there was no correlation between kinesiophobia, pain, functionality and hand-grip strength. However, kinesiophobia followed pain's decrease path. Future use of kinesiophobia in LET studies is strongly suggested.

The number of participants was calculated arbitrary. Other trials' sample (10-75 participants per group) were taken into consideration [77,78]. However, Consolidated Standards of Reporting Trials (CONSORT) reports explicitly that the sample should be calculated not chosen [78-81].

Tendons' damage cannot be restored but pain, functionality and the relevant assessments can be differentiated [64]. This trial's variables changed results radically; we assume it is the high dosage under supervision TNT, which, in combination with the application of 448kHz CRMRF, made the results not only change but improve more even after 2 months. The outcomes suggest the conduction of a main study with longer period of remeasurement.

Conclusion

Research on cost-effectiveness should be conducted, since cost is a factor of choosing treatment modalities. Last but not least, it is advised that future studies conclude about the parameters of the exercise itself and 448 kHz CRMRF, as well.

Bibliography

1. Bisset LM and Vicenzino B. "Physiotherapy management of lateral epicondylalgia". *Journal of Physiotherapy* 61 (2015): 174-181.

2. Coombes B., *et al*. "Management of Lateral Elbow Tendinopathy: One Size Does Not Fit All". *Journal of Orthopaedic and Sports Physical Therapy* 45.11 (2015): 938-949.

3. Cioce T., *et al*. "Assessment and Management of Lateral Elbow Pain in Physiotherapy Clinical Practice: an Italian National Survey". *Muscles, Ligaments and Tendons Journal* 10.4 (2020): 698-712.

4. Shiri R and Viikari-Juntura E. "Lateral and medial epicondylitis: Role of occupational factors". *Best Practice and Research in Clinical Rheumatology* 25.1 (2011): 43-57.

5. Ahmad Z., *et al*. "Lateral epicondylitis: A review of pathology and management". *The Bone and Joint Journal* 95B (2013): 1158-1164.

6. Behrens SB., *et al*. "A review of modern management of lateral epicondylitis". *The Physician and Sportsmedicine* 40.2 (2012): 34-40.

7. Samaras P., *et al*. "Greek physiotherapists' contemporary knowledge and practice for lateral elbow tendinopathy: An online survey". *Musculoskeletal Science and Practice* 57 (2022): 102502.

8. Manias P and Stasinopoulos D. "A controlled clinical pilot trial to study the effectiveness of ice as a supplement to the exercise programme for the management of lateral elbow tendinopathy". *British Journal of Sports Medicine* 40.1 (2006): 81-85.

9. Stasinopoulos D and Stasinopoulos I. "Comparison of effects of Cyriax physiotherapy, a supervised exercise programme and polarized polychromatic non-coherent light (Bioptron light) for the treatment of lateral epicondylitis". *Clinical Rehabilitation* 20.1 (2006): 12-23.

10. Stasinopoulos D., *et al*. "Comparison of effects of a home exercise programme and a supervised exercise programme for the management of lateral elbow tendinopathy". *British Journal of Sports Medicine* 44 (2010): 579-583.

11. Stasinopoulos D., *et al*. "448 kHz Capacitive Resistive Monopolar Radiofrequency and a Supervised Exercise Programme in Patients with Lateral Elbow Tendinopathy? A Research Protocol". *EC Orthopaedics* 11.4 (2020): 98-106.

12. Cho Y., *et al*. "Healthcare Utilization for Lateral Epicondylitis: A 9-Year Analysis of the 2010-2018 Health Insurance Review and Assessment Service National Patient Sample Data". *Healthcare (Basel)* 10.4 (2022): 636.

13. Amar E., *et al*. "Lateral epicondylitis treatment: international survey of surgeons' preferences and literature review". *International Journal of Clinical Practice* 68.11 (2014): 1383-1387.

14. Vaquero-Picado A., *et al*. "Lateral epicondylitis of the elbow". *EFORT Open Review* 1.11 (2016): 391–397.

15. Lapner P., *et al*. "Nonoperative treatment of lateral epicondylitis: a systematic review and meta-analysis". *JSES International* 6.2 (2022): 321-330.

16. Weber C., *et al*. "Efficacy of physical therapy for the treatment of lateral epicondylitis: a meta-analysis". *BMC Musculoskeletal Disorders* 25 (2015): 223.

17. Stasinopoulos D. "A Progressive Loading Supervised Exercise Program and Manual Therapy for The Management of Lateral Elbow Tendinopathy: A Case Report". *Journal of Clinical Case Studies Reviews and Reports* 4.6 (2022): 1-4.

18. Kumaran B. "Physiological and clinical effects of Radiofrequency-based therapy". PhD. University of Hertfordshire, Hatfield, UK (2017).

19. Fousekis K., *et al*. "Posterior thigh thermal skin adaptations to radiofrequency treatment at 448 kHz applied with or without Indiba® fascia treatment tools". *The Journal of Physical Therapy Science* 32.4 (2020): 292-296.

20. Stasinopoulos D., *et al*. "448 kHz Capacitive Resistive Monopolar Radiofrequency in Patients with Rotator Cuff Tendinopathy. A Pilot Study". *Acta Scientific Orthopaedics* 3.4 (2020): 16-20.

21. Stasinopoulos D., *et al*. "The Effectiveness of Thermal Mode of 448 KHz Capacitive Resistive Monopolar Radiofrequency in Continuous Wave in Patients with Chronic Rotator Cuff Tendinopathy: A Clinical Trial". *Journal of Orthopedics and Bone Disorders* 4.1 (2020): 196.

22. Piponas K and Stasinopoulos D. "The Effectiveness of 448 kHz Capacitive Resistive Monopoles Radio Frequency in Acute Ankle Sprain: A Case Report". *Journal of Complementary and Integrative Medicine* 7 (2021): 141.

23. Stasinopoulos D. "The Effectiveness of 448 kHz Capacitive Resistive Monopoles Radiofrequency in Acute Lateral Elbow Tendinopathy: A Case Report". *Annals of Clinical Case Reports-Physiotherapy* 4 (2019): 1613.

24. Pienimäki TT., *et al*. "Progressive Strengthening and Stretching Exercises and Ultrasound for Chronic Lateral Epicondylitis". *Physiotherapy* 82.9 (1996): 522-530.

25. Shrier I and Gossal K. "Myths and truths of stretching: individualized recommendations for healthy muscles". *The Physician and Sportsmedicine* 28.8 (2000): 57-63.

26. Stanish W., *et al*. "Tendinitis: its etiology and treatment". *British Journal of Sports Medicine* 35.2 (2001): 139.

27. Fyfe I and Stanish W. "The use of eccentric training and stretching in the treatment and prevention of tendon injuries". *Clinical Sports Medicine* 11 (1992): 601-624.

28. Stasinopoulos D., *et al*. "An exercise programme for the management of lateral elbow tendinopathy". *British Journal of Sports Medicine* 39 (2005): 944-947.

29. Bhatt JB., *et al*. "Middle and lower trapezius strengthening for the management of lateral epicondylalgia: a case report". *Journal of Orthopaedic and Sports Physical Therapy* 43 (2013): 841-847.

30. Sharma M., *et al*. "Effect of adding rotator cuff strengthening to therapeutic ultrasound and wrist extensor eccentric exercise for lateral epicondylalgia-a randomized clinical trial". *International Journal of Health Sciences and Research* 5 (2015): 250-257.

31. Demosthenous M., *et al*. "Comparison of the Effectiveness of Eccentric-Concentric Training of Wrist Extensors and Eccentric - Concentric Training Combined with Supinator Strengthening in Healthy Population". *Journal of Orthopedic Research and Physiotherapy* 3.2 (2017): 036.

32. Park JY., *et al*. "Prospective evaluation of the effectiveness of a home-based program of isometric strengthening exercises: 12-month follow-up". *Clinics in Orthopedic Surgery* 2 (2010): 173-178.

33. Pearson SJ., *et al*. "Immediate and Short-Term Effects of Short- and Long-Duration Isometric Contractions in Patellar Tendinopathy". *Clinical Journal of Sport Medicine* 30.4 (2020): 335-340.

34. Vicenzino B., *et al*. "The initial effects of a cervical spine manipulative physiotherapy treatment on the pain and dysfunction of lateral epicondylalgia". *Pain* 68.1 (1996): 69-74.

35. Shridhar Thakare P., *et al*. "Long term effect of cyriax physiotherpy with supervised exercise program in subjects with tennis elbow". *International Journal of Physics* 1.2 (2016): 74-82.

36. Rompe J., *et al*. "Validation of the Patient-rated Tennis Elbow Evaluation Questionnaire". *Journal of Hand Therapy* 20.1 (2007): 3-10.

37. Papadopoulos K., *et al*. "Greek adaptation and validation of the Patients Rated Tennis Elbow Evaluation (PRTEE)". *Journal of Hand Therapy* 28.3 (2015): 286-291.

38. Stasinopoulos D., *et al*. "Greek adaptation and validation of the Patients Rated Tennis Elbow Evaluation (PRTEE)". *Journal of Hand Therapy* 28.3 (2015): 286-290.

39. Stratford P and Levy D. "Assessing valid change over time in patients with lateral epicondylitis at the elbow". *Clinical Journal of Sport Medicine* 4 (1994): 88-91.

40. Hamilton GF., *et al*. "Measurement of grip strength: validity and reliability of the sphygmomanometer and Jamar grip dynamometer". *Journal of Orthopaedic and Sports Physical Therapy* 16.5 (1992): 215-219.

41. Miller R., *et al*. "The Tampa Scale: a Measure of Kinesophobia". *The Clinical Journal of Pain* 7.1 (1991): 51.

42. Georgoudis G., *et al*. "Physiotherapy assessment in painful musculoskeletal conditions: Validity and Reliability of the Greek Tampa Scale of Kinesiophobia". (pilot study). 2005, Poster 119, World Institute of Pain, European Federation of IASP Chapters, International Forum on Pain Medicine, Sofia, Bulgaria (2005).

43. Huang J., *et al*. "A Mixed Comparison of Interventions for Kinesiophobia in Individuals With Musculoskeletal Pain: Systematic Review and Network Meta-Analysis". *Frontiers in Psychology* 13 (2022): 886015.

44. Kirthika V., *et al*. "Prevalence of kinesiophobia among the tennis elbow patients in India". *GJRA* 7.11 (2018): 2277.

45. Xu Y., *et al*. "Effect of multi-modal therapies for kinesiophobia caused by musculoskeletal disorders: a systematic review and meta-analysis". *International Journal of Environmental Research and Public Health* 17 (2020): 9439.

46. Tseng SY., *et al*. "The Effectiveness of Whole-Body Vibration and Heat Therapy on the Muscle Strength, Flexibility, and Balance Abilities of Elderly Groups". *International Journal of Environmental Research and Public Health* 20.2 (2023): 1650.

47. Kumaran B and Watson T. "Treatment using 448kHz capacitive resistive monopolar radiofrequency improves pain and function in patients with osteoarthritis of the knee joint: a randomised controlled trial". *Physics* 105.1 (2019): 98-107.

48. Avendaño-Coy J., *et al*. "Capacitive resistive monopolar radiofrequency at 448 kHz plus exercising versus exercising alone for subacromial pain: A sham-controlled randomized clinical trial". *Clinical Rehabilitation* 36.11 (2022): 1450-1462.

49. Gadhvi M and Waseem M. "Physiology, Sensory System". StatPearls Publishing LLC, Tampa, Florida, United States (2022).

50. Pienimäki TT., *et al*. "Progressive Strengthening and Stretching Exercises and Ultrasound for Chronic Lateral Epicondylitis". *Physics* 82.9 (1996): 522-530.

51. Vicenzino B. "Lateral epicondylalgia: a musculoskeletal physiotherapy perspective". *Manual Therapy* 8.2 (2003): 66-79.

52. Coombes BK., *et al*. "Effect of corticosteroid injection, physiotherapy, or both on clinical outcomes in patients with unilateral lateral epicondylalgia: A randomized controlled trial". *JAMA* 309 (2013): 461-469.

53. Yelland M., *et al*. "Prolotherapy injections and physiotherapy used singly and in combination for lateral epicondylalgia: a single-blinded randomised clinical trial". *BMC Musculoskeletal Disorders* 20.1 (2019): 509.

54. Solveborn SA. "Radial epicondylalgia ('tennis elbow'): treatment with stretching or forearm band. A prospective study with long-term follow-up including range-of-motion measurements". *Scandinavian Journal of Medicine and Science in Sports* 7.4 (1997): 229-237.

55. Nilsson P., *et al*. "A prospective pilot study of a multidisciplinary home training programme for lateral epicondylitis". *Musculoskeletal Care* 5.1 (2007): 36-50.

56. Svernlöv B and Adolfsson L. "Non-operative treatment regime including eccentric training for lateral humeral epicondylalgia". *Scandinavian Journal of Medicine and Science in Sports* 11.6 (2001): 328-334.

57. Stasinopoulos D and Stasinopoulos I. "Comparison of effects of eccentric training, eccentric-concentric training, and eccentric-concentric training combined with isometric contraction in the treatment of lateral elbow tendinopathy". *Journal of Hand Therapy* 30.1 (2017): 13-19.

58. Stasinopoulos D and Johnson MI. "Treatment/management for tendinopathy". *BMJ* (2004).

59. Stasinopoulos D and Manias P. "Comparing Two Exercise Programmes for the Management of Lateral Elbow Tendinopathy (Tennis Elbow/Lateral Epicondylitis)-A Controlled Clinical Trial". *The Open Access Journal of Science Technology* (2013): 1.

60. Chen Z and Baker NA. "Effectiveness of eccentric strengthening in the treatment of lateral elbow tendinopathy: A systematic review with meta-analysis". *Journal of Hand Therapy* 34.1 (2021): 18-28.

61. Karanasios S., *et al*. "Exercise interventions in lateral elbow tendinopathy have better outcomes than passive interventions, but the effects are small: a systematic review and meta-analysis of 2123 subjects in 30 trials". *British Journal of Sports Medicine* 55.9 (2021): 477-485.

62. Raman J., *et al*. "Effectiveness of different methods of resistance exercises in lateral epicondylosisea systematic review". *Journal of Hand Therapy* 25.1 (2012): 5e26.

63. MacDermid JC., *et al*. "Hand therapist management of the lateral epicondylosis: a survey of expert opinion and practice patterns". *Journal of Hand Therapy* 23.1 (2010): 18e30.

64. Rio E., *et al*. "Tendon neuroplastic training: changing the way we think about tendon rehabilitation: a narrative review". *British Journal of Sports Medicine* 50 (2016): 209-215.

65. Welsh P. "Tendon neuroplastic training for lateral elbow tendinopathy: 2 case reports". *The Journal of the Canadian Chiropractic Association* 62.2 (2018): 98-104.

66. Stasinopoulos D. "The Management of Lateral Elbow Tendinopathy using Tendon Neuroplastic Training: A Case Report". *Acta Scientific Orthopaedics* 2.3 (2019): 2-5.

67. Plinsinga ML., *et al*. "Evidence of Nervous System Sensitization in Commonly Presenting and Persistent Painful Tendinopathies: A Systematic Review". *Journal of Orthopaedic and Sports Physical Therapy* 45.11 (2015): 864-875.

68. Stasinopoulos D. "Scapular and rotator cuff strengthening in patients with lateral elbow tendinopathy". *Hong Kong Physiotherapy Journal* 37 (2017): 25-26.

69. Gatchel RJ., *et al*. "The biopsychosocial approach to chronic pain: scientific advances and future directions". *Psychological Bulletin* 133.4 (2007): 581-624.

70. Sørvoll M., *et al*. "The Significance of Touch in Pediatric Physiotherapy". *Frontiers in Rehabilitation Sciences* 3 (2022): 893551.

71. Bateman M., *et al*. "Development of a core outcome set for lateral elbow tendinopathy (COS-LET) using best available evidence and an international consensus process". *British Journal of Sports Medicine* 56 (2022): 657-666.

72. Lupton-Smith A., *et al*. "Measurement of hand grip strength: A cross-sectional study of two dynamometry devices". *South African Journal of Physiotherapy* 78.1 (2022): 1768.

73. Jeswani K and Rathi M. "The Tampa scale of Kinesiophobia and pain, disability and grip strength in patients with lateral Epicondylalgia: A narrative review of the literature". *International Journal of Sciences and Applied Research* 7.2 (2021): 365-369.

74. Mallows A., *et al*. "Association of psychological variables and outcome in tendinopathy: a systematic review". *British Journal of Sports Medicine* 51.9 (2015): 743-748.

75. Thiese M., *et al*. "Psychosocial Factors Related to Lateral and Medial 387 EpicondylitisResults From Pooled Study Analyses". *International Journal of Occupational and Environmental Medicine* 58.6 (2016): 588-593.

76. Feleus A., *et al*. "Kinesiophobia in patients with non-traumatic arm, neck and shoulder complaints: a prospective cohort study in general practice". *BMC Musculoskeletal Disorder* 8 (2007): 117.

77. Julious SA. "Sample size of 12 per group rule of thumb for a pilot study". *Pharmaceutical Statistics* 4.4 (2005): 287-291.

78. Lewis M., *et al*. "Determining sample size for progression criteria for pragmatic pilot RCTs: the hypothesis test strikes back!" *Pilot Feasibility Study* 7 (2021): 40.

79. Eldridge SM., *et al*. "CONSORT 2010 statement: extension to randomised pilot and feasibility trials". *Pilot Feasibility Study* 2.1 (2016).

80. Thabane L., *et al*. "A tutorial on pilot studies: what, why and how". *BMC Medical Research Methodology* 10.1 (2010).

81. Browne RH. "On the use of a pilot sample for sample size determination". *Statistics in Medicine* 14.17 (1995): 1933-1940.