THERAPEUTIC EXERCISE IN THE MANAGEMENT OF LATERAL ELBOW TENDINOPATHY

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KEYWORDS: Tendinopathy/tendinitis, Elbow/forearm, Therapeutic exercise, isometric, eccentric, Stretching

ABSTRACT

Lateral elbow tendinopathy is the most common cause of pain in this joint.
Although it is also widely known as 'tennis elbow' as it affects 50% of tennis players, especially beginners who learn the one-handed backhand, LET often develops as a work-related condition and therefore constitutes a serious public health problem: only 10% of all affected patients play tennis.
The typical clinical presentation is characterized by pain and reduction of strength and function with considerable repercussions on daily activities. Although signs and symptoms of LET are clear, as well as the definition of the diagnosis, to date no ideal treatment has yet emerged; clinicians advocate a conservative approach as the first choice of management and physiotherapy, with its wide range of treatments, is commonly recommended: therapeutic exercise has shown good clinical results and the goal of this review is to evaluate its effectiveness in the management of the aforementioned clinical picture.
for the realization of this revision was made reference to the guidelines for reporting systematic reviews PRISMA Statement (PRISMA-P checklist).
Randomized clinical trials were identified using strings, which were specifically constituted on each used database: MEDLINE, Cochrane Library and PEDro. After the elimination of repeated articles from the search in the various databases and studies that did not meet the inclusion criteria, the selection took place by reading the title, abstract and full text. Subsequently, the evaluation of the internal validity of the studies was carried out with the Rob 2.0 of the Cochrane Collaboration.
The strings produced a total of 1418 items. After reading the title, abstract and full text, only 12 works were really relevant to the research question and containing the pre-established inclusion criteria.
Therapeutic exercise has been found to be the safest, cheapest and most effective means in the management of lateral elbow tendinopathy; all the included trials have precisely outlined the dosage, type and principle of application in different populations without restrictions of the time of onset of symptoms. Unsupervised isometric exercise demonstrated a considerable reduction in pain and disability in the short term. Eccentric exercise, the most contemplated type, was effective in reducing the painful symptom and increasing the grip strength. Stretching, a valid therapeutic strategy often associated with other modes of intervention, has recorded significant benefits related to painless grip strength, function and VAS, overlapping with the results obtained in the comparison groups.
However, the heterogeneity of the trials included for the type administered, the size of the samples examined and the type of outcomes considered, makes it difficult to extract an objective and clear answer to the clinical question. Better targeting clinical practice in LET management is the goal of future research, defining exercise programs with statistically and/or clinically significant superiority.

INTRODUCTION

Lateral elbow tendinopathy, or "tennis elbow", is a common degenerative muscle-tendon disease of the origin of the extensor carpi radialis brevis and the extensor digitorum communis at the level of the lateral humeral epicondyle. Repetitive occupational or athletic activities involving wrist extension and supination are believed to be the cause. Typical symptoms include pain in the region of the lateral epicondyle, with possible irradiation on the forearm, pain with wrist extension and weakened grip strength. The diagnosis is made clinically through anamnesis and physical examination; however, a thorough understanding of differential diagnosis is critical to avoid unnecessary testing and therapies. Lateral elbow pain affects up to 3% of the population, and although usually self-limiting, symptoms can persist for more than 1 year up to 20% of patients. Men and women appear to be equally predisposed and the age of onset is usually between 35 and 55 years. The typical duration of symptoms is between 6 and 24 months; up to 90% of patients say they recover within 1 year.

However, 5 to 10% of patients develop chronic symptoms and eventually undergo invasive treatment such as surgery. Social costs are important: absenteeism in 10-30% of all patients with an average duration of 12 weeks. Three interactive components seem to play a role in its pathophysiology, namely: local tendon pathology, alterations of the pain system and impairment of the motor system. Pathological changes in the tendon consist of angiofibroblastic hyperplasia with increased number of cells, fundamental substance and disorganized and immature collagen formation. Ultrasound (USG) has shown tendon thickening or thinning, focal areas of hypoechogenicity, tendon lacerations, calcification, and even bone irregularity. USG Doppler in patients with LET also showed nonfunctional neoangiogenesis. The current opinion is that it is not an inflammation and therefore the old term epicondylitis turns out to be improper. The change in pain perception can also contribute to the pathophysiology: substance P, a powerful pain modulator, has been shown to be located at the level of the ECRB tendon. In addition, LET is itself associated with hy-

peralgesia and increased response to harmful stimuli. It may also be associated with a reduced pain threshold beyond the site of interest, especially at the level of the cervical spine: studies have actually reported a high prevalence of neck pain in patients with this condition. Impairment of the motor system consists of reduced strength with morphological changes in muscles and impaired motor control. The three components of the model mentioned above probably work differently for each patient: some patients with LET may have multiple disorders of the pain system, while others may have a more local tendon pathology. To date, no standardized and universally accepted program for conservative treatment has been established, nor is there consensus on what results to measure, which makes it difficult, if not impossible, to compare the different modalities; various have been described: orthoses, non-steroidal anti-inflammatory drugs, physical therapy, manual therapy, ultrasound, laser therapy, shock waves, corticosteroid infiltrations, taping, injections of sodium hyaluronate, botulinum toxin or Platelet Rich Plasma (PRP). However, there is a lack of evidence to select the best treatment, and the choice of therapy depends on the experience of the management team, the expertise of the clinician, and the patient's response.

The effects of therapeutic exercise in the management of lateral elbow tendinopathy have been discussed, but no convincing evidence has been put forward so far, so the review aims to define its role.

MATERIALS AND METHODS

Before the drafting of this narrative revision, a revision protocol was drawn up according to the indications of the PRISMA-P checklist.

Objectives And Review Question

Primary objectives:

1. To investigate the effectiveness of therapeutic exercise applied as a single treatment strategy through all possible variables in the population diagnosed with LET;
2. To understand what may be the best type of exercise in terms of effectiveness in patients with LET.

Secondary objective:

3. To compare therapeutic exercise with the effectiveness of other types of intervention.

Inclusion And Exclusion Criteria

The P.I.C.O. (population, intervention, comparison, outcome) model was used for processing the search string.

Inclusion criteria:

- randomized controlled clinical trials (RCTs)
- adult population (of both sexes) with medical and/or clinical diagnosis of LET (positivity to provocative tests, pain on palpation and in grip activities associated with reduced strength, possible sensorimotor alterations and manual dexterity)
- conservative treatment strategies based on therapeutic exercise, without limits of comparison studies reported in English or Italian

Exclusion criteria:

- subjects diagnosed with LET concomitant with disorders associated with: scapulohumeral joint, primary nerve problems (radial tunnel syndrome), rheumatic pathologies, cervical radiculopathy, HRT and collateral ligamentous compartment lesions
- multimodal treatments that do not consider therapeutic exercise as the only treatment strategy

Research Strategies

The systematic review will be conducted through the consultation of three different databases (Pubmed MEDLINE, PEDro and Cochrane). If necessary, it will also be searched in the grey literature (bibliography of included studies, Google scholar). The search on the MEDLINE database will be performed by combining key terms and mesh terms using Boolean operators such as "AND" and "OR" in order to expand the search.

Search string for Pubmed MEDLINE:

((((((((((("tennis elbow"[MeSH Terms]) OR ("Tennis Elbows")) OR ("Lateral Epicondylitis")) OR ("Lateral Humeral Epicondylitis")) OR ("Elbow Tendinopathies")) OR ("lateral elbow pain")) OR ("lateral elbow tendinopathy")) OR ("lawn tennis elbow")) OR ("lateral tennis elbow")) OR ("lateral Epicondylosis")) OR ("Lateral epicondylalgia")) OR ("unilateral lateral epicondylalgia")((((((((((((((((((((((((((("Exercise Therapy"[MeSH Terms]) OR ("Remedial Exercise")) OR ("Remedial Exercises")) OR ("Rehabilitation Exercise")) OR ("Rehabilitation Exercises")) OR ("Exercise Movement Techniques"[MeSH Terms])) OR ("Exercise Movement Technics")) OR (Concentric)) OR ("concentric exercise")) OR (eccentric)) OR ("eccentric exercise")) OR ("Isometric Exercise")) OR ("Isometric Exercises")) OR ("Isotonic Contractions")) OR ("eccentric exercise")) OR ("motor control exercise")) OR ("Sensory Feedback")) OR ("Sensory Feedbacks")) OR ("Sensorimotor Feedbacks")) OR ("Isometric Contraction"[MeSH Terms])) OR ("Isometric Contractions")) OR ("Active Stretching")) OR ("Muscle Stretching Exercises"[MeSH Terms])) OR ("concentric graded exercise")) OR ("eccentric training")) OR ("eccentric-concentric training")) OR ("Eccentric exercises")) OR ("supervised exercise programme")) OR ("Mulligan's mobilization with movement technique")) OR ("mobilization with movement technique")((((((((((((((((((((Pain[MeSH Terms]) OR (Ache)) OR (Aches)) OR ("Hand Strength"[MeSH Terms])) OR ("Hand Strengths")) OR (Grip)) OR (Grips)) OR (Grasp)) OR (Grasps)) OR ("Muscle strength dynamometer")) OR ("Patient-Rated Tennis Elbow Evaluation")) OR (PRTEE)) OR ("visual analog scale")) OR (VAS)) OR ("grip strength")) OR (Dynamometer)) OR ("pressure pain threshold")) OR (PPT)) OR ("Quick DASH")) OR (DASH)) OR ("maximum grip strength")) OR ("numeric rating scale")) OR (NRS).

Criteria For The Selection Of Studies

After the elimination of the duplicate records, obtained from the various databases, the articles are selected by title and abstract. Therefore, the full text of potentially relevant studies will be found, only when the title and abstract suggest their suitability, carefully verifying the correspondence with the inclusion and exclusion criteria.

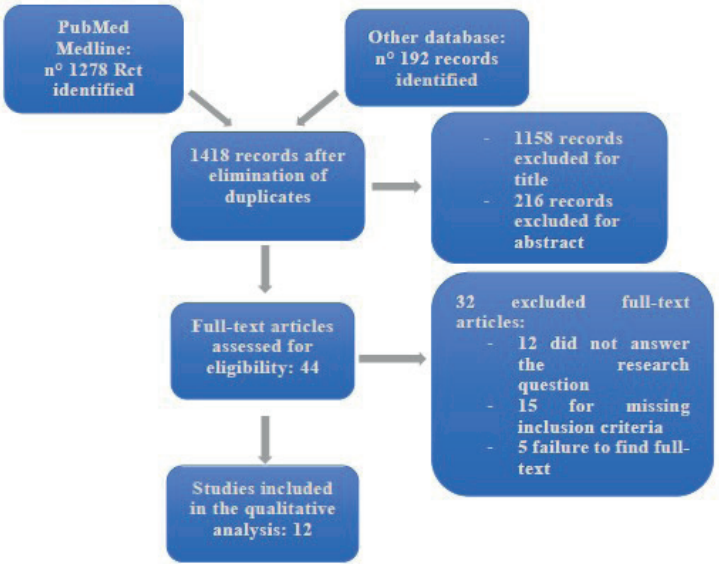
Results

Selection Of Studies

The search string thus constructed produced a total of 1278 Rct on the PubMed interface, Medline, while another 192 studies were detected by other sources (Cochrane Library and PEDro). With the elimination of duplicate articles, common to searches carried out on the different databases, 1418 records were examined. After reading the only title, 1158 studies were excluded, reaching 260 studies.
Reading the abstract it was found that 216 studies did not meet the inclusion criteria.
Finally, after full-text screening, only 12 studies were considered eligible. Of the 32 records excluded:

- 12 did not answer the research question;
- 15 did not meet the eligibility criteria;
- 5 were not found full-text

The selection process is shown in the PRISMA flowchart (Tab. 1)



Tab. 1 - Study selection flow Chart

Data Extraction

In order to facilitate the analysis of the results, an extraction and synthesis of the data from each study was made *(Table 2)*, in order to summarize the key points. Table 2 has been organized by inserting the data into the following entries:

- title, author and year of publication;
- characteristics of the participants: medical diagnosis and inclusion criteria of the studied population;
- type of intervention and follow-up period: dosage/dosage, frequency of administration and duration of follow-up;
- sample: number of participants and distribution of the sample of study groups;
- lost at follow-up
- outcome: type of the various outcomes considered
- results: outcome scores detected at the end of follow-up

Title, author, year of publication	Participants and features	Intervention and follow-up period	Sample	Lost at followup	Outcome	Results
"Unsupervised Isometric Exercise versus Wait-and-See for Lateral Elbow Tendinopathy" Vincenzino et al. (2020) *Rct*	Age between 18 and 70 years; unilateral elbow pain lasting ≥6 weeks; average severity of pain during the last week ≥2 on an 11-point numerical rating scale (NRS, 0 = no pain, 10 = worst pain imaginable); pain caused by at least 2 between: grip, palpation of the lateral epicondyle, stretching of the extensor muscles of the forearm or wrist, extension of the second or third finger and reduced painless gripping force.	All participants received a personalized 20- minute session with the physiotherapist. Participants assigned to the exercise group received additional information and advice to complete an isometric exercise program without supervision in a home environment for 8 weeks. The program consisted of a daily exercise of isometric wrist extension, performed using a water container with a handle as resistance and progressed weekly by adding water to the container or increasing the duration of the exercise, according to standardized criteria. The control group (wait-and-see) did not undergo any treatment during the follow- up period.	40 participants: -21 assigned to the intervention group -19 assigned to the control group	1 participant lost in the follow-up (intervention group) because unable to participate	The primary outcome measures were: LET self-assessment (PRTEE), specific questionnaire (0 = no pain or disability, 100 = worst pain or disability), global change assessment (GROC) on a six- point Likert scale (6= fully recovered; 5=much improved; 4=improved; 3=equal; 2=worse; 1=much worse) and painless grip strength (N) measured using a digital dynamometer. Tripled measurements with rest intervals of 30 seconds were collected and average values were used for analysis. Secondary outcome measures related to pain severity and sensitivity (thermal pain) were also detected. The pressure pain threshold (kPa) was measured using a portable digital algometer (probe size of 1 cm2) (Somedic AB, Farsta, Sweden) with pressure applied at a rate of 40 kPa - s − 1 (21). Cold and hot pain thresholds were initially measured using the Modula Sensory Analyzer Thermotest (probe size of 12.5 cm2)	At 8 weeks the worst pain was lower in the exercise group than in the control group (MDS, −0.80; 95% CI, −1.45 to −0.14; P = 0.017), while no difference was observed between the 2 groups for resting pain (MDS, −0.20; 95% CI, −0.83 to 0.42; P = 0.516). No differences were observed between the groups for: pressure pain threshold (SMD, −0.34; 95% CI, −0.97 to 0.29; P = 0.289), cold pain threshold (SMD, −0.06; 95% CI, −0.69 to 0.57; P = 0.849) or heat pain threshold (SMD, −0.24; 95% CI, −0.87 to 0.38; P = 0.454) at the elbow. This randomized controlled trial with blinded evaluator outcomes showed that isometric exercise overall is no better than control when applied as monotherapy.

Title, author, year of publication	Participants and features	Intervention and follow-up period	Sample	Lost at followup	Outcome	Results
"A randomized controlled trial of eccentric vs. concentric graded exercise in chronic tennis elbow (lateral elbow tendinopathy)" Peterson et al. (2014) ***Rct***	The inclusion criteria were: age between 20 and 75 years, symptoms of LET for more than three months with verified diagnosis from pain on palpation, pain during stretching (Mill test) and Maudsley test positivity	The eccentric exercise group was commissioned to perform it in three sets of 15 repetitions, in total 45 weight lowering maneuvers, once a day. In both groups the load was increased weekly by one hectogram (one deciliter of water). The concentric exercise group was tasked with lifting a weight by extending the wrist of the affected arm upwards and lowering it again with the healthy limb in three sets of 15 repetitions, in total 45 weightlifting maneuvers, once a day. The follow-up period was 3 months and both groups performed the exercises at home	120 participants: -60 assigned to the eccentric exercise group -60 assigned to the concentric exercise group	Data loss due to partial non- response (missing data in the questionnaires or protocols returned) was 1.3% (very low).	The primary outcome of the study, i.e. pain reduction, was measured in all visits with two visual analog scales (VAS) ranging from "no pain" (= 0) to the "worst pain imaginable" (= 100). The pain at the first scale was measured during the maximum voluntary contraction of the forearm extensor muscles (Cozen Test) and the second during the maximum muscle stretching of the ECRB and long muscles with a load (90° abduction of the arm followed by complete pronation of the forearm with a 3 kg handlebar). The secondary result, the muscle strength of the forearm extenders, was also measured in all visits using a dynamometer (AMETEK Measurement & Calibration Technologies Division, Florida, USA). Tertiary outcomes, overall arm function, and quality of life aspects were measured at baseline and at follow-up of three, six, and 12 months.	Both groups improved from the beginning to the end of the 12- month of follow-up in terms of pain during maximum voluntary contraction and maximum muscle lengthening, as well as muscle strength; but the eccentric group tended to have a more rapid and coarse decrease in pain during maximum voluntary contraction and maximum muscle lengthening, as well as a more rapid increase in muscle strength than the concentric group. Chronic lateral elbow tendinopathy responds favorably to a gradual eccentric exercise program rather than a concentric one
"Comparison of effects of eccentric training, eccentric-concentric training, and eccentric-concentric training combined with isometric contraction in the treatment of lateral elbow tendinopathy" D. D. Stasinopoulos e I. Stasinopoulos (2016) ***Rct***	Patients over the age of 18 years with lateral elbow pain for at least 4 weeks examined and evaluated between January 2011 and October 2011 in a private rehabilitation center located in Athens. Patients included in the study tested positive for at least 2 of the following tests: 1. Tomsen test: wrist extension with resistance 2. Middle finger test against resistance 3. Mill test: complete passive flexion of the wrist 4. Dynamometer test	In all 3 groups, 3 sets of 15 repetitions of slow and progressive exercises of the wrist extenders (eccentric, concentric and isometric respectively) were performed with one minute of rest between sets. The training took place 5 times a week for 4 weeks. Patients were told to continue exercise even with mild pain (<4 VAS). However, they were told to stop exercising if the pain became disabling (>8 VAS). With acceptable pain/discomfort the load was increased using free weights. Static stretching exercises of the wrist extenders (maintaining the position for 45'') were performed in all treatment groups 6 times in each session, 3 times before and 3 times after the exercises, with a rest interval of 30 seconds between each repetition.	34 participants:-11 assigned to eccentric training -12 assigned to eccentriccon-centric training -11 assigned to eccentriccon-centric training associated to isometric	0 lost at followup	Each patient was evaluated at the beginning (week 0), at the end of follow-up (week 4) and at 1 month (week 8) after the end of treatment. Pain was measured on the VAS scale, where 0 (cm) was the least pain imaginable and 10 (cm) was the worst pain imaginable. The force was measured in pounds with dynamometer that had adjustable handles to fit the different sizes of the hand.	The pain recorded (VAS) at the beginning of the follow-up was 6.5 cm (95% confidence interval (CI) 1/4 6.3-7.1) for the entire sample (n 1/4 34). There were no significant differences between the pain groups (P>.05 ANOVA 1-way). At week 4 there was a drop in VAS of about 4 units in all groups compared to the initial pretreatment (P <.0005, paired t test). The magnitude of the reduction was significantly greater for eccentric-concentric training combined with isometric training than for eccentric-concentric training (+0.8 VAS units) and eccentric training (+1.0 VAS units, P <.05). There was no significant difference between eccentricconcentric training and eccentric training with regard to pain (+0.2 units VAS, P> .05) and gripping force (+3.3 painless units of grip strength, P> .05). The results of this study indicate that eccentricconcentric training combined with isometric contraction produced the greater effect of treatment at the end of follow-up, both in terms of pain reduction and improvement of function.

Title, author, year of publication	Participants and features	Intervention and follow-up period	Sample	Lost at followup	Outcome	Results
"The Effectiveness of Kinesiotaping, Sham Taping or Exercises Only in Lateral Epicondylitis Treatment: A Randomized Controlled Study" Esra Giray et al. (2019) *Rct*	30 patients (mean age 44.46 -} 9.92; 26 females, 4 male patients) admitted on an outpatient basis at a Rehabilitation clinic of a university hospital were randomized into three groups: group 1 (kinesiotaping plus exercises), group 2 (sham taping plus exercises) and group 3 (control group - exercises only); the inclusion criteria were: 1) duration of symptoms less than 12 weeks, 2) pain on palpation and 3) pain provocation with at least one of the following tests: resistance to middle finger extension (Maudsley test), resistance to wrist extension or Mill test.	All groups received an instruction on activity modification and a home exercise program that included stretching and eccentric reinforcement exercises performed in a sitting position with maximum elbow extension, forearm pronation, and maximum wrist extension. Patients were instructed to continue the exercise even if with mild pain and to stop if it became intolerable. The load was then increased using free weights. Three sets of 10 repetitions were performed during each treatment, with one minute of rest between each series. The eccentric exercises consisted of 3 sets of 10 wrist and elbow flexion repetitions; 2 sets of 10 repetitions for strengthening of the wrist extenders, starting from 50% maximum strength and increasing endurance every week; two sets of 10 repetitions consisting of 20'' of stretching and 10'' of relaxation for flexors and wrist extenders. The follow-up period was 4 weeks.	33 randomized participants: 10 patients for each of the three groups	3 dropouts	The main outcome measure of the study was the PRTEE questionnaire (assesses pain and disability/function in patients with LET). Secondary results: -Maximum and painless grip force. The strengths were detected using a portable dynamometer (JAMAR, Sammons Preston, Inc., Bolingbrook, IL) in the standardized position recommended by the American Society of Hand Therapy, with a rest period of 20''. 3 tests were carried out and the average values were recorded. -Pain was assessed with the VAS scale at rest, in ADLs and at night on a 10 cm scale. -Disability of the arm, shoulder and hand was assessed with the QuickDASH scale. All assessments were performed before and after treatment and at 4 weeks of follow-up. In addition, VAS at rest and during daily activity and gripping strength were also detected in the kinesiotaping and sham taping groups to evaluate the immediate effect, immediately after tape application.	At 4 weeks after treatment PRTEE scores were statistically lower in the kinesiotaping plus exercise group compared to sham taping plus exercise group and the exercise-only group. There were significant differences between the groups regarding QuickDASH and VAS scores (at rest and in ADLs) at rest 4 weeks after treatment: Kinesiotaping in addition to exercises proved more effective in terms of pain and disability than sham taping plus exercises and exercises

Title, author, year of publication	Participants and features	Intervention and follow-up period	Sample	Lost at followup	Outcome	Results
"Prospective randomizedcontrolled trial in the treatment of lateral epicondylitis with a new dynamic wrist orthosis" J. Nowotny et al. (2018) ***Rct***	Patients with LET for more than 3 months were randomized into a physiotherapy group (PT group) and a physiotherapy group plus dynamic wrist orthosis (PT + O group). Patients were prospectively included in the time period from December 2013 to March 2016 in three different specialized shoulder/elbow centers. The inclusion criteria were symptoms for more than 3 months and a Placzek score greater than 4. Clinical evaluation took place before surgery and after, at 12 weeks and 12 months	Physiotherapy consisted of performing daily eccentric strengthening exercises (three times a day for 10 minutes). For standardization, all patients received the same exercise sheet with the description. Initially there was supervision by a physiotherapist in six sessions. The number and duration of exercises were recorded at 12 weeks of follow-up.	Of the 61 initial patients, 31 were followed after 12 weeks and 22 after 12 months. 29 patients (43%) were male, the mean age was 46 years and 44 patients (66%) had their right elbow involved	A dropout rate of about 50% was found in the 12 weeks and about two-thirds during the 12 months of follow-up with no difference between groups	The gripping force (painless and maximum) was detected with a portable electronic dynamometer (TL-LSC 100, Litexpress GmbH Coesfeld, Germany). The ROM in flexion, extension, pronation and supination were evaluated with a manual goniometer. Further evaluations were: PRTEE, Placzek Scorela, VAS and SEV (subjective elbow evaluation). All parameters were recorded at baseline, at 12 weeks and at 12 months.	There was a significant reduction in pain (VAS) after 12 weeks only in the PT + O group: 6.5–3.7 [p = 0.001]; PT: 4.7–4.1 [p = 0.468]). After 12 months, the reduction was notable in both groups (PT + O: 1.1 (SD: 1.0) [p = 0.000]; PT: 1.3 (SD: 1.6) [p = .000]). SEV increased in both groups after 12 weeks (PT + O: 36–63 [p = .000]; PT: 47–57 [p = .190]). The maximum pain free grip force improved in both groups considerably after 12 weeks (PT + O: 9.9 from (SD: 12.1) to 18.9 (SD: 14) [p = 0.009]; PT: 14.8 (SD: 17.5) to 19.9 (SD: 17.1) [p = 0.031]) and in the 12 months of follow-up (PT + O: 25.3 (SD: 9.3) [p = 0.028]; PT: 32.2 (SD: 15.9) [p = .013]). The average values of the maximum gripping force increased slightly in the PT + O group, but there was a stronger trend in the physiotherapy group (PT + O: from 20.4 (SD: 16.5) to 20.6 (SD: 12.5) [p = 0.943]; PT: 23.8 (SD: 17.3) to 26.7 (SD: 16.7) [p = 0.051]). At 12 months of followup, the maximum grip strength: - in the group PT + O: 26.9 (SD: 9.9) [p = 0.889] - in the physiotherapy group: 33.7 (SD: 14.5) [p = 0.061]). The Placzek score was reduced: from 8.25 (SD: 1.84) to 3.5 (SD: 2.75) [p = .0001] after 12 weeks for the PT + O group and from 8.1 (SD: 1.76) to 3.8 (SD: 2.98) [p = 0.000] 17 for the PT group. After 12 months this score was: in the PT + O group at 0 [p = .000] and in the PT group at 2.0 [p = .000]. PRTEE improved in both groups after 12 weeks (PT + O: 52.8–31.3 [p = 0.002]; PT: 48.6– 37.6 [p = .185]) and 12 months (PT + O: 16.15 [p = .000]; PT:16.6 [p = .000]), although the reduction at 12 weeks was not significant for the PT group.

Title, author, year of publication	Participants and features	Intervention and follow-up period	Sample	Lost at followup	Outcome	Results
"Comparison of Effectiveness of Supervised Exercise Program and Cyriax Physiotherapy in Patients with Tennis Elbow (Lateral Epicondylitis): A Randomized Clinical Trial" R. Viswas et al. (2011) ***Rct***	The included patients were aged 30 to 45 years with a diagnosis of LET and duration of symptoms was between 8 and 10 weeks. Inclusion criteria: -grip pain -pain with resisted extension -pain when the wrist is passively flexed with extended elbow. -pressure pain on the lateral epicondyle of the humerus	Patients assigned to group A were supervised in an ET program: static stretching of the extensor carpi radialis brevis (performed in a sitting position with elbow in extension, pronation of the forearm and flexion of the wrist with ulnar deviation) and eccentric strengthening of the wrist extenders. The stretching position was maintained for 30-45'' and was performed 3 times before and 3 times after the eccentric exercise part of the treatment (with a 30'' interval between each stretching session) for a total of 6 repetitions. Patients were instructed to continue eccentric exercise even if they experienced mild discomfort and to stop it if the pain worsened. Subsequently, the load was increased using weights (3 sets of 10 repetitions with a break of 1' between each series). Group B patients received physiotherapy with Cyriax treatment (10' deep transverse massage) followed immediately by a single application of Mill manipulation. All patients were treated 3 times a week for 4 weeks for a total of 12 treatment sessions.	20 patients (10 male and 10 females) randomly distributed in the 2 groups.	O lost at followup	Pain intensity was measured using the visual analog scale (VAS). The VAS assessment tool is considered a valid and reliable measurement method. The functional status of the patients was assessed with the Tennis Elbow Function Scale (TEFS). For the compilation of the TEFS the patients listed the functional tasks that were difficult to perform due to their problem and were informed to evaluate, accordingly, the intensity of their pain. Higher scores are indicative of higher levels of disability. The TEFS assessment tool has been found to have a high test retest reliability (ICC 0.92) and moderate construct validity (Pearson correlation coefficient 0.47)	Although both groups showed a significant reduction in pain compared to the pre-test score, comparison of VAS scores showed a greater reduction in pain in group A than in group B (statistically significant). VAS Post (n. participants, Mean rank, Sum of ranks): - Group A 10 7.10 71.00 - Group B 10 13.90 139.00 Although in both groups there were significant improvements in functional status compared to the pre-test score, the intergroup comparison of TEFS scores demonstrated a greater, statistically significant reduction in group A than in group B. TEFS Post (n. participants, Mean rank, Sum of ranks): - Group A 10 6.65 66.50 - Group B 10 14.35 143.50

Title, author, year of publication	Participants and features	Intervention and follow-up period	Sample	Lost at followup	Outcome	Results
"Effectiveness of Mulligan Mobilization with movement compared to supervised exercise program in subjects with lateral epicondylitis" H. Rahman et al. (2016) ***Rct***	60 patients who met the following inclusion criteria were included in the study: - grip pain; -pain at the resisted extension of the wrist; -pain at passive flexion of the wrist with elbow in extension; -pressure pain on the lateral epicondyle of humerus. The initial assessment of their pain profile was measured using the VAS scale and the grip force of the hand with a dynamometer held by the patients, squeezing it for 5''. Pain intensity was measured using VAS.	After initial measurements, subjects were randomly assigned to 2 groups for 4 weeks of follow-up. Group Aàmobilization with Movement by Mulligan: mobilization is performed with the subject lying in a supine position with the elbow extended and the forearm pronate, through the use of a strap. MWM was performed with 10 repetitions for 3 sets; Group Bàsupervised Exercise Programàthe exercise program includes static stretching of extensor carpi radialis brevis, followed by eccentric strengthening of the wrist extenders. Static stretching was performed in a sitting position with elbow extension, forearm pronation and wrist flexion with ulnar deviation. The stretching force was applied according to the patient's tolerance and the position was held for a duration of 30– 45'' (3 times before and 3 times after the eccentric exercise with a 60" pause between each session). The eccentric exercise was performed in a sitting position with full elbow extension, forearm pronation and wrist in maximum extension. From this position, the patient slowly lowered the wrist in flexion 30 times. The load was increased using weights based on the patients' 10 MRIs. 3 sets of 10 rips were performed during each treatment, with one-minute of rest interspersed between each series.	60 participants: 30 assigned to group A 30 assigned to group B	0 lost at followup	1. Pain intensity: measured by the VAS scale. 2. Hand grip strength: measured by a dynamometer	The study showed that during 4 week of follow-up both the MWM program and the supervised exercise program are effective in reducing pain and increasing hand grip strenth in patients with LET. However, there was a significant change in group A (MWM) compared to group B (supervised exercise program) regarding the reduction of pain and the increase in hand grip strength. So the null hypothesis was rejected. The group that performed MWM for 4 weeks showed significantly greater improvement in pain reduction and increased hand grip strength than the supervised exercise program. Hand grip strength (HGS) was measured with handle dynamometer HGS score was noted on the first and last day of treatment (after 4 weeks). Among the 2 groups the post-test analysis of the VAS P value is <0.01 and HGD is <0.02.

Title, author, year of publication	Participants and features	Intervention and follow-up period	Sample	Lost at followup	Outcome	Results
"Chronic Lateral Epicondylitis: Comparative Effectiveness of a Home Exercise Program Including Stretching Alone versus Stretching Supplemented with Eccentric or Concentric Strengthening" J.A. Martinez-Silvestrini et al. (2005) ***Rct***	Subjects with lateral elbow pain (>3 months) were recruited meeting the inclusion criteria. The inclusion criteria were as follows: pain localized to the lateral epicondyle of the elbow, continuous symptoms present for more than three months and pain evoked with the resisted extension of the wrist, the resisted extension of the middle finger, or chair lift test.	The objective of the present study was to compare outcomes (strength, pain, function) over six weeks of home-based exercise program. Patients were randomly assigned to the 3 groups: - stretching group -concentric group: stretching + concentric reinforcement program; -eccentric strengthening group: stretching + eccentric strengthening program. The concentric and eccentric strengthening groups performed the exercises for three sets of ten repetitions once a day, with 2-5 minutes of rest between sets. The resistance band (light, medium or heavy) was chosen by means of a test of 10 repetitions. The length of the resistance band was adjusted so that it was rather difficult to perform ten repetitions. Patients were instructed to increase fascia resistance gradually.	94 partecipants	13 lost at follow- up	At the initial visit and six-week follow-up, pain-free gripping strength (PFG) was measured and questionnaires (PRFEQ, DASH, SF- 36) and the VAS scale were filled out.	All groups showed improvements at the end of follow-up. Although the results did not demonstrate a significant difference between the three groups at six weeks, it is interesting to note that the eccentric group did not worsen compared to the other groups (it's often associated with an exacerbation of symptoms). Eccentric strengthening for wrist extenders in subjects with LET demonstrated improvement at six weeks, although it was not statistically different from that achieved with a conservative program with stretching or concentric strengthening.
"Efficacy of a forearm band in addition to exercises compared with exercises alone for lateral epicondylitis: A multicenter, randomized, controlled trial" T. Nishizuka et al. (2016) Rct	A total of 121 patients aged 18 years and older with LET\ were assisted in 5 affiliated hospitals between August 2012 and December 2013. Lateral elbow tendinopathy was diagnosed in patients who had a history of care for more than a week in those 5 hospitals and had both palpation pain and Thomsen test positivity.	Patients in both groups were instructed to stretch the wrist extenders with the shoulder flexed at 90°, the elbow extended and the opposite hand carrying the wrist in flexion. These exercises were performed for 30'', 3 times a day, for 6 months. All patients were evaluated at the beginning of follow-up and after 1, 3, 6 and 12 months (end of follow-up). Patients in the orthosis group wore a forearm band (Tennis elbow supporter) for more than 6 hours a day for at least 6 months.	110 patients recruited	102 of the 110 participants (51 in each group) with an average age of 53 completed the study, so 8 lost at follow-up.	Outcome examined measures: - Hand10: a reliable and valid self-administered questionnaire used to evaluate upper limb disorders; - Thomsen test and middle finger extension test -pain on palpation	Hand10: at one month the score tended to be lower in the "band" than in the "non-band" group. However, there was no significant difference between the groups at 1, 3, 6 and 12 months (P = 0.09, 0.48, 0.37 and 0.21, respectively). Similarly, there were no significant differences in pain score between the 1, 3, 6, and 12-month groups (P=0.46, 0.45, 0.39, and 0.14, respectively), as well as in the assessment of pressure pain, Thomsen test, and middle finger extension test.

Title, author, year of publication	Participants and features	Intervention and follow-up period	Sample	Lost at followup	Outcome	Results
"Astym treatment vs. eccentric exercise for lateral elbow tendinopathy: a randomized controlled clinical trial" T. L. Sevier e C.W. Stegink- Jansen (2015) Rct	The study eligibility criteria consisted of ages 18 to 65 years with lateral elbow pain lasting more than 12 weeks and at least two of the following: acute pain on palpation of the extensor and/or lateral epicondyle area, lateral epicondyle palpation pain with resisted extension, and passive wrist flexion (with fully extended elbow).	Subjects randomized to the EE group performed stretching (3 times a day for 30'') and eccentric strengthening exercises (2 times a week) at home for 4 weeks in order to expand the therapeutic program. The eccentric exercises consisted of 6 total exercises per elbow, wrist and shoulder and had to be performed 2 times a week for 2 sets (painless) of 15 rips each, increasing to 3 sets (if tolerated) and progressing towards increasing resistance by thera-band. Subjects assigned to the Astym treatment group were treated 2 times a week for 4 weeks. At least 2 days of rest were granted between sessions to allow for an adequate response to regenerative stimulation. The Astym group performed supervised EE and stretching during biweekly treatment, while the EE group performed them at home. Both groups performed the same exercises with guidelines for intensity progression. Treatment with Astym was given at 8 weeks subjects in the EE group recalcitrant to the exercise program.	A total of 107 subjects (113 elbows) were enrolled in the study with an average age of 46.9 years	0 dropouts	The primary outcome measure was DASH, while secondary outcome measures were: -Analog scale (VAS at 100 mm) for pain in activities (0, no pain; 100, the worst possible pain); -Visual analog scale (VAS) for function (0, no use of hand/wrist/arm; 100 normal use of the hand / wrist / arm); -Maximum grip force measured at extended elbow.	78.3% (36/46) of the elbows in the Astym group responded by meeting the resolution criteria from initial treatment to 4 or 8 weeks after the confirmation period. In the EE group, 40.9% (18/44) of the elbows met the resolution criteria at 4 or 8 weeks after the confirmation period. The results show that subjects who received Astym treatment reported greater reductions in disability (DASH) and significant improvements in maximum grip strength compared to EE subjects. Subjects not responding to the EE program were allowed delayed access to Astym therapy resulting in statistically significant improvements in DASH scores, pain in activities and function; long-term follow-up revealed that these subjects (with delayed access) retained their benefits at 6 and 12 months, achieving results similar to those obtained by patients who received Astym as initial treatment.
"Prospective Evaluation of the Effectiveness of a Home-Based Program of Isometric Strengthening Exercises: 12- Month Followup" Jin-Young Park et al. (2010) *Rct*	Participants recruited in the study met the following inclusion criteria: 1) clinical diagnosis of LET with palpation pain on the origin of ECRB and aggravation of symptoms with resisted extension of the middle finger with extended elbow; 2) persistent symptoms from at least 6 weeks despite non- strengthening conservative treatments, including medications, application of an orthosis and physical therapy; 3) ability to fill out questionnaires.	In both groups, isometric muscle strengthening exercises (4 sets of 50 daily repetitions) were performed without pain. Patients in group D, unlike those in group I, undertook the exercises after 4 weeks of oral nonsteroidal antiinflammatory drugs. Participants were followed for a 12-month follow-up.	31Partecipants were enrolled in this study: 16 patients were in group I and 15 in group D	5 lost at follow-up	Three self-reported outcome measures were used: VAS, Nirschl/Pettrone score and Mayo elbow performance score.	Study results indicate that isometric exercise reduces pain and improves elbow function in a short period. After three months of follow-up, there were no differences in the other variables: no significant differences between the 2 groups regarding VAS or MEPS were detected at follow-up of 3 and 6 months.

Title, author, year of publication	Participants and features	Intervention and follow-up period	Sample	Lost at followup	Outcome	Results
"Efficacy of low-energy extracorporeal shockwave therapy and a supervised clinical exercise protocol for the treatment of chronic lateral epicondylitis: A randomised Controlled study" B. Sarkar et al. (2013) ***Rct***	The inclusion criteria were: prediagnostic cases of LET, presence of symptoms for more than 6 months, presence of palpation pain at the level of the lateral epicondyle, positivity to the Thomsen test and the Maudsley test.	Experimental group A received low- energy extracorporeal shockwave treatment and supervised exercise once a week for 3 weeks, while control group B received the same type of supervised exercise program three times a week. All participants in both groups were instructed to do an exercise program twice a day for 4 weeks of follow-up.	30 partecipants: 15 for each group	0 lost at follow-up	Pain intensity, painless grip strength and hand function were used as outcome measures of the study. They were evaluated at the initial visit and at the end of the 4th week. Pain intensity was measured using the Visual Analog Scale (VAS). The Arm, Shoulder and Hand Questionnaire (DASH) was used to assess hand function. The painless gripping force, which was recorded in Millimeters of mercury (mmHg), was converted to kilograms (kg) using a formula.	At the beginning of follow-up, no significant difference was found between the two groups in terms of VAS, grip strength and DASH scores. In both groups, the reduction in pain intensity (VAS) from baseline to the 4th week of follow-up ($p < 0.001$) was statistically significant. Comparison of the groups at week 4 revealed a significantly lower VAS score in group A than in group B ($p < 0.001$). Pain free grip force was significantly improved from baseline to week 4 in both groups ($p < 0.05$). The mean improvement was 4.1 in group A and 1.6 in group B. There was a tendency for greater improvement in pain free grip force in group A, but the difference did not reach statistical significance ($p > 0.025$). Similarly, both groups demonstrated improvements in hand function, detected by DASH scores over time. The average improvement was 28.3 in Group A and 17.2 in Group B. As a result, group A had a significantly lower DASH score than group B at the end of follow-up ($p=0.001$).

Tab. 2 - *summary table for each study*

Risk Of Bias Of Selected Studies

The evaluation of the internal validity in the individual works collected was performed by a single reviewer in line with the Cochrane Collaboration methodology considering the risk of bias in the seven subjective domains, as reported in the Cochrane Handbook for Systematic Review of Intervention (Tab. 3 and Figures 1 and 2).

- Random sequence generation
- Allocation concealment
- Blinding of partecipants and personnel
- Blinding of outcome assessment
- Incomplete outcome data
- Selective reporting
- Other bias

Synopsis Of

Vincenzino et al. 2020		
Randomization (Selection BIAS)	*Low Risk*	The randomization sequence was computer-generated and was performed by a researcher not involved in data collection
Hidden assignment (Selection BIAS)	*Low Risk*	Participants were randomly assigned to the intervention or control group using opaque envelopes
Blinded patients and therapists (Performance BIAS)	*Unclear*	There is not enough information to judge the presence of such BIAS
Blinded Assessment (Detection BIAS)	*Low Risk*	Outcome measurements were collected from the beginning until the end of the 8-week follow-up by an evaluator unaware of treatment assignment
Incomplete data (Attrition BIAS)	*Low Risk*	The statistical analysis of the data was performed respecting the intention-to-treat analysis (using Stata Version 14 software)
Selective Reporting (BIAS Reporting)	*Low Risk*	The study is available in the Australian New Zeland Clinical Trial Registry (ACTRN12615001136594)
Other BIAS	*Low Risk*	The study appears free from possible other BIAS

Peterson et al. 2014

Randomization (Selection BIAS)	*Low Risk*	The randomization sequence was created using SAS Software that generated random numbers with equal probability of distribution
Hidden assignment (Selection BIAS)	*Low Risk*	Participants were randomly assigned to the eccentric or concentric exercise group using a random block distribution system
Blinded patients and therapists (Performance BIAS)	*High Risk*	Data collection was not blinded, as the observer monitored ET adherence from start to finish follow-up. There is no information on the blindness of patients
Blinded Assessment (Detection BIAS)	*Low Risk*	Data were collected by a blinded evaluator throughout the follow-upperiod in 5 appointments: at 1, 2, 3, 6 and 12 months
Incomplete data (Attrition BIAS)	*Low Risk*	Data loss due to a partial non-response (missing data in the returned questionnaires or protocols) is 1.3%. The statistical analysis of the data has been performed respecting the intention-to-treat analysis, using the SAS software version 9.3.23
Selective Reporting (Reporting BIAS)	*Low Risk*	The study is available on the SAGE Publishing platform (DOI:1177/0269215514527595)
Other BIAS	*Low Risk*	The study appears free from possible other BIAS

D. Stasinopoulos e I. Stasinopoulos 2016

Randomization (Selection BIAS)	*Low Risk*	A randomization was applied to parallel groups, in order to follow each participant always in the same treatment group
Hidden Assignment (Selection BIAS)	*Low Risk*	Participants were randomly assigned to the three intervention groups by drawing lots
Blinded patients and therapists (Performance BIAS)	*Low Risk*	Communication and interaction (verbal and non-verbal) between the FT and the PCA have been reduced to a minimum; no indication has been given to patients regarding the potential beneficial effects of the treatments provided or any feedback on their performance
Blinded Assessment (Detection BIAS)	*Low Risk*	All assessments were conducted blinded by the doctor (not aware of the group to which the participants belonged)
Incomplete data (Attrition BIAS)	*Unclear*	There is not enough information to judge the presence of such BIAS
Selective Reporting (BIAS Reporting)	*Low Risk*	The study is available in the Journal of Hand Therapy [30 (2017) 13-19]
Other BIAS	*High Risk*	Small sample and absence of placebo/sham group (important to evaluate the absolute effectiveness of a treatment)

E. Giray et al. 2019

Randomization (Selection BIAS)	*Low Risk*	Randomization was performed by an independent researcher not involved in any other aspect of the trial, using opaque and sealed envelopes.
Hidden Assignment (Selection BIAS)	*Low Risk*	The assignment was randomly made using blind assessors
Blinded patients and therapists (Performance BIAS)	*Low Risk*	Patients and evaluator unaware of treatment assignment
Blinded Assessment (Detection BIAS)	*Low Risk*	Assessments were made after the removal of the taping to ensure blindness of the assessors. At the final evaluation they were asked to guess the patient's assignment group
Incomplete data (Attrition BIAS)	*Low Risk*	Among the 33 patients there were only 3 dropouts
SelectiveReporting (Reporting BIAS)	*Low Risk*	The study is available in the American Academy of Physical Medicine and Rehabilitation doi.org/10.1002/pmrj.12067
Other BIAS	*Unclear*	There is not enough information to make a final judgment of high or low risk

J. Nowotny et al. 2018

Randomization (Selection BIAS)	*Low Risk*	Randomization took place using an external database (Redcap-Research Electronic Data Capture)
Hidden Assignment (Selection BIAS)	*Low Risk*	The patients involved were randomized into two groups: the first group received physiotherapy (exercises) and the second a dynamic orthosis for the wrist
Blinded patients and therapists (Performance BIAS)	*Unclear*	There is not enough information to judge the presence of such BIAS
Blinded Assessment (Detection BIAS)	*Unclear*	There is not enough information to judge the presence of such BIAS
Incomplete data (Attrition BIAS)	*Low Risk*	Statistical analysis was performed with SPSS Statistics software for descriptive statistics, with significance level $p<0.5$. The drop-out rate was found equally in both groups
SelectiveReporting (Reporting BIAS)	*Low Risk*	The study is available in the European Journal of Medical Research doi.org/10.1186/s40001-018-0342-9
Other BIAS	*High Risk*	Heterogeneity of researchers and therapists due to the multicenter approach

R.Viswas et al. 2011

Randomization (Selection BIAS)	*Low Risk*	Participants were randomly distributed into the two groups
Hidden Assignment (Selection BIAS)	*Unclear*	There is not enough information to judge the presence of such BIAS
Blinded patients and therapists (Performance BIAS)	*Unclear*	There is not enough information to judge the presence of such BIAS
Blinded Assessment (Detection BIAS)	*Low Risk*	An independent observer, not aware of the patient assignment group, blindly assessed the outcomes
Incomplete data (Attrition BIAS)	*Unclear*	There is not enough information to judge the presence of such BIAS
Selective Reporting (Reporting BIAS)	*Low Risk*	The study is available in The ScientificWorld Journal (Volume 2012, Article ID 939645, 8 doi:10.1100/2012/939645)
Other BIAS	*Unclear*	There is not enough information to judge the presence of such BIAS

Rahman et al. 2016

Randomization (Selection BIAS)	*Low Risk*	Simple random sampling. "After obtaining informed consent from the patients, they were randomly assigned to the two groups"
Hidden Assignment (Selection BIAS)	*Unclear*	There is not enough information to judge the presence of such BIAS
Blinded patients and therapists (Performance BIAS)	*Unclear*	There is not enough information to judge the presence of such BIAS
Blinded Assessment (Detection BIAS)	*Unclear*	There is not enough information to judge the presence of such BIAS
Incomplete data (Attrition BIAS)	*Low Risk*	The analysis of the data was performed respecting the intention-to-treat
SelectiveReporting (Reporting BIAS)	*Low Risk*	The study is available in the International Journal of Physiotherapy and Research (Vol 4(2):1394-1400. ISSN 2321-1822) DOI: http://dx.doi.org/10.16965/ijpr.2016.104
Other BIAS	*High Risk*	The absence of a real control group affects the internal validity of the study

J.A. Martinez-Silvestrini et al. 2005

Randomization (Selection BIAS)	*Low Risk*	94 subjects with LET were randomly assigned in 3 groups: stretching, eccentric reinforcement with stretching and concentric reinforcement with stretching
Hidden Assignment (Selection BIAS)	*Unclear*	There is not enough information to judge the presence of such BIAS
Blinded patients and therapists (Performance BIAS)	*Unclear*	There is not enough information to judge the presence of such BIAS
Blinded Assessment (Detection BIAS)	*Unclear*	There is not enough information to judge the presence of such BIAS
Incomplete data (Attrition BIAS)	*Low Risk*	Continuous baseline characteristics (age, height and weight) as well as PFG, VAS, total PRFEQ and DASH measurements were compared between the three groups using a unidirectional variance (ANOVA) analysis in an intent-to-treat analysis
Selective Reporting (Reporting BIAS)	*Low Risk*	The study is available in Journal of Hand Therapy doi:10.1197/j.jht.2005.07.007 J (HAND THER. 2005;18:411–420)
Other BIAS	*Unclear*	There is not enough information to judge the presence of such BIAS

T. Nishizuka et al. 2016

Randomization (Selection BIAS)	*Low Risk*	Participants were randomly assigned into 2 treatment groups using a random number generating table on the web
Hidden Assignment (Selection BIAS)	*Unclear*	There is not enough information to judge the presence of such BIAS
Blinded patients and therapists (Performance BIAS)	*High Risk*	The main limitation of this work is that it is a non-blinded study
Blinded Assessment (Detection BIAS)	*High Risk*	The main limitation of this work is that it is a non-blinded study
Incomplete data (Attrition BIAS)	*Low Risk*	"Of the 110 patients recruited, 102 completed the study; however, we adhered to the principles of intention-to-treat and data from these patients were included in our analysis."
SelectiveReporting (Reporting BIAS)	*Low Risk*	The study is available in the Journal of Orthopaedic Science doi.org/10.1016/j.jos.2016.11.011
Other BIAS	*Unclear*	There is not enough information to judge the presence of such BIAS

T. L. Sevier e C.W. Stegink-Jansen 2015

Randomization (Selection BIAS)	*Low Risk*	Randomization was performed using random number generating tables from PCs
Hidden Assignment (Selection BIAS)	*Low Risk*	There is not enough information to judge the presence of such BIAS
Blinded patients and therapists (Performance BIAS)	*High Risk*	"Due to the nature of the treatments, it was not possible to blind physiotherapists and participants"
Blinded Assessment (Detection BIAS)	*Low Risk*	The evaluator was blinded, as were the doctors who evaluated the recovery of the subjects.
Incomplete data (Attrition BIAS)	*Low Risk*	The analysis of the data took place in 2 ways: considering in the first instance only the patients who had received the treatment and, secondly, through the intention-to-treat analysis. Both types of analysis provided the same results. No dropouts found
SelectiveReporting (Reporting BIAS)	*Low Risk*	The study is available at Peer J DOI 10.7717/peerj.967
Other BIAS	*Unclear*	There is not enough information to judge the presence of such BIAS

Jin-Young Park et al. 2010

Randomization (Selection BIAS)	***Low Risk***	Randomization was performed using a random number generation program
Hidden Assignment (Selection BIAS)	*Unclear*	There is not enough information to judge the presence of such BIAS
Blinded patients and therapists (Performance BIAS)	*Unclear*	There is not enough information to judge the presence of such BIAS
BlindedAssessment (Detection BIAS)	*Low Risk*	3 self-reported outcome measures were used to evaluate the effectiveness of treatment protocols. "At 12 months, clinical outcomes with respect to the home exercise program were evaluated through phone calls to participants"

Incomplete data (Attrition BIAS)	*Low Risk*	The results for groups I and D were compared using the Mann-Whitney Test for MEPS, the Student test t for VAS and the chi square test for the Nirschl/Pettrone score. Statistical analysis was performed using SPSS ver. 13.0 (SPSS Inc., Chicago, IL, USA). All tests were performed using a 95% confidence level
Selective Reporting (Reporting BIAS)	*Low Risk*	The study is available at Clinics in Orthopedic Surgery doi:10.4055/cios.2010.2.3.173
Other BIAS	*Unclear*	There is not enough information to judge the presence of such BIAS

B. Sarkar et al. 2013

Randomization (Selection BIAS)	*Low Risk*	Participants were assigned to experimental group (A) or control group (B) by random generation of computer numbers
Hidden Assignment (Selection BIAS)	*Unclear*	There is not enough information to judge the presence of such BIAS
Blinded patients and therapists (Performance BIAS)	*Low Risk*	All patients were treated in isolation so that none of them could know the assignment treatment of the other participants.
Blinded Assessment (Detection BIAS)	*High Risk*	The evaluator was aware of the participant's assignment group
Incomplete data (Attrition BIAS)	*Low Risk*	The statistical analysis of the data was performed respecting the intent-to-treat analysis (using the Software SPSS Inc., Chicago, IL, USA)
Selective Reporting (Reporting BIAS)	*Low Risk*	The study is available in www.sciencedirect.com and at Hong Kong Physiotherapy Journal (2013) 31,19-24
Other BIAS	*Unclear*	There is not enough information to judge the presence of such BIAS

Tabl. 3 - *and following summaries for the risk of BIAS present in each study*

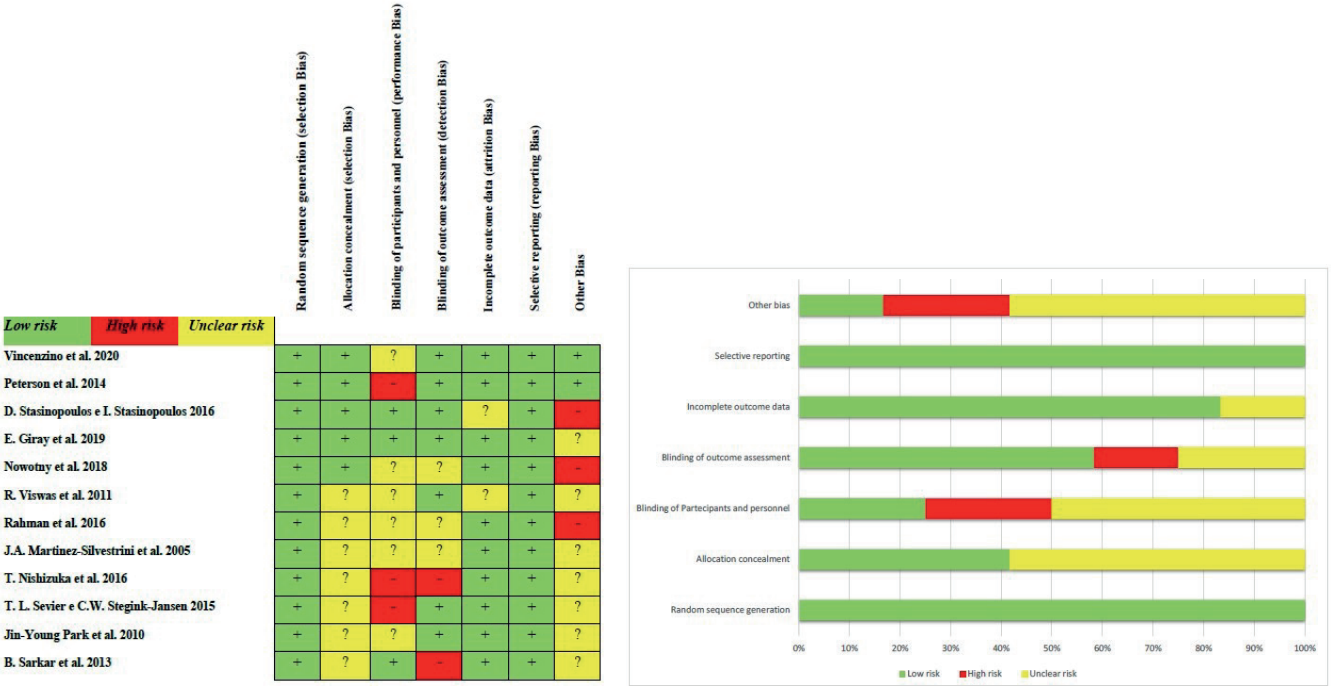


Fig. 1 e 2 - summary graphs of the risk of bias

Isometric Exercise

Two studies have examined this type of exercise, in home-based mode, testing its effectiveness through the presence of a real 'wait and see' control group (Vincenzino et al. 2020) and in association or not with the intake of non-steroidal anti-inflammatory drugs (Jin-Young Park et al. 2010).

The work of Vincenzino et al., considered of high methodological quality, investigates the effect of an unsupervised 8-week isometric exercise program, compared to the control group, in terms of pain, disability and improvement of grip strength. All participants received a personalized 20- minute session with the physiotherapist and, subsequently, the subjects assigned to the group of exercises were instructed, with information and advice, to complete the program of isometric exercises for 8 weeks in a home environment, therefore without supervision. The program consisted of a daily exercise of isometric wrist extension, performed using a container of water with a

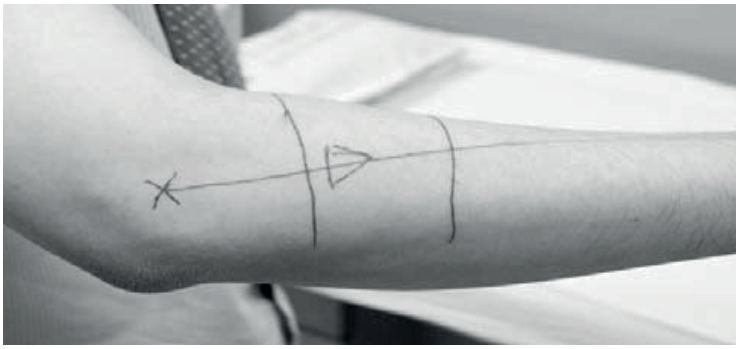


Fig. 3 - The image shows the position of the lateral epicondyle (asterisk) and the direction of the ECRB; explaining the anatomical position of the ECRB and the effectiveness of isometric exercise, patients were projected towards the treatment goal

handle as resistance and progressed weekly by adding water to the container or increasing the duration of the exercise, according to standardized criteria. Participants were instructed to hold the container full of water with the affected forearm pronate and resting on the edge of a table, elbow flexed at about 90° and wrist extension at 30°, while the other hand was used to lower the water container.

To determine the initial load, the maximum voluntary contraction (MVC) of the wrist extenders on the healthy arm was detected using a digital dynamometer. The initial load was equivalent to 20% of the MVC of the unaffected limb and increased to 35% by the seventh week (participants were instructed to add the equivalent of 5% more MVC of water every two weeks: weeks 3, 5, 7); moreover, the TUT (Time Under Tension), every other week, was administered in two modes: 4 isometric seals for 30'' (TUT 120'') and 3 isometric seals for 45'' (TUT 135''). Participants in the exercise group were asked to fill out a daily paper diary to record adherence to the prescribed load, duration and series achieved, and symptoms experienced during and after exercise. For each exercise session, participants assessed their perceived effort with the Category Ratio 0-10 scale (CR-10) and pain intensity with NRS. At 8 weeks, PRTEE scores were better in the exercise group than in the control group (SMD, −0.92; 95% confidence interval [CI], −1.58 to −0.26; P = 0.006), while no statistically significant difference was found for the success rate at GROC (86% improvement rate, 18 out of 21 subjects in the isometric exercise group, compared to 63%, 12 out of 19 subjects, in the control group), for pain free grip strength, for pressure, cold or heat pain threshold; therefore, isometric exercise produced an important reduction in pain and disability (PRTEE) with a surprising and parallel equality of results in terms of mechanical or thermal hyperalgesia between the two groups. Among the limitations of the study there is precisely the lack of difference in results at GROC which, unlike other outcome measures, specific for the evaluation of a specific or limited domain of the patient's state of health, allows the patients themselves to decide which factors to consider representative of their overall improvement; secondly, the GROC (measured using a six-point scale and dichotomized between success and non-success) may not have been sufficiently sensitive to change; Third, it is highly plausible that an unsupervised isometric exercise program may be insufficient to improve the overall perception of health related to the tendon problem. On the other hand, a strong point of this study is that it provides a detailed description of the intervention, according to the descriptors of the mechanobiological exercises of Toigo and Boutellier and the Consensus on Exercise Reporting Template, approved internationally. Since only one of the three primary outcome measures (PRTEE, GROC, painless grip strength) is significantly improved after isometric exercises, it is doubtful whether this form of exercise can be effective as the only treatment in LET.

In the study of Jin-Young Park et al. 2010 only patients with LET present for more than 6 weeks in the absence of improvement were included: 16 of them were enrolled in group I, which immediately undertook the isometric exercise program, and 15 in group D, in which the same exercises were administered after 4 weeks of taking non-steroidal anti-inflammatory drugs. The strengthening exercise program consisted of four sets of 50 daily repetitions with isometric seals of 10''; participants were instructed to perform them painlessly, in order to increase compliance and reduce potential and further injury to affected tissues.

To evaluate the effectiveness of the home-based treatment program, 3 outcome measures were considered: the VAS, the modified Nirschl/Pettron scale, for pain and function, and the Mayo elbow performance score that investigates pain, range of motion, stability and function. Given the simplicity of the execution of the exercise, without the need for equipment, a good degree of compliance was found. Patients recorded in a diary the days in which they performed the exercises: at 3 months of follow-up the compliance rate was above 70%: 0.56 in group I and 0.75 in group D; at 6 months, the compliance rate dropped to 0.43 and 0.38 respectively, and at 1 year of follow-up, surprisingly, 48% of subjects continued to follow the treatment protocol, regardless of symptoms. At the first month of follow-up there was a significant difference between the two groups in terms of pain reduction with lower mean VAS score in group I compared to group D ($p < 0.01$) and, with regard to the resumption of function in the absence of pain, with differences in the scores of the modified Nirschl/Pettron scale (from the first month of follow-up 6 patients of group I , 37%, and 2 of group D, 13%, resumed all activities in the absence of pain or with occasional presence); however, at 3-6 and 12 months of follow-up no differences in VAS and MEPS were found. At the final follow-up, 88% of all participants performed pain-free activities. The results of this study indicate that isometric exercise reduces pain and improves elbow function in an initial period of treatment (within 4 weeks).

Eccentric Exercise

The Swedish study by **Peterson et al. 2014** compared eccentric exercise with concentric exercise in a population of 120 participants with TLG present for more than 3 months. The two groups followed for three months, at home, the programs of the two different types of exercise, with a progressive increase in the load, according to the pre-established methods: the initial load was standardized to 1 kg for women and 2 kg for men, increasing weekly by one hectogram (one deciliter of water) the weight of the plastic con-

tainer raised from the handle with flexed elbow and pronate forearm (3 sets of 15 repetitions for each type of exercise); this standardization, implemented for the purpose of simplifying the execution, could represent a critical issue of the study, since, to maximize the effect of the exercise, it would have been more appropriate to individualize the adaptation of the initial load (1 RM). To compare the timing of pain reduction and increased muscle strength, a linear regression analysis was performed using 6 measurements and it was found that the eccentric exercise group had a significantly lower average pain level during maximum voluntary contraction ($p < 0.0001$) and maximum muscle stretching ($p < 0.001$), as well as the average maximum muscle strength ($p < 0.05$), rated with dynamometer (AMETEK Measurement & Calibration Technologies Division, Florida, USA). The eccentric exercise group demonstrated a 10% higher and faster response rate than the concentric exercise group both during maximum voluntary contraction (Cozen Test) and in maximum muscle stretching with a load of 3 kg (Modified Empty can test). No significant difference was found with regard to the DASH questionnaire and other quality of life measurements (Gothenburg Quality of Life instrument) assessed at the beginning of follow-up, at 3, 6 and 12 months.

The work of **D. Stasinopoulus and I. Stasinopoulos 2016** experimented in a follow-up period of 4 weeks three types of physiotherapy protocols in subjects suffering from LET for at least 1 month, examined and evaluated between January and October 2011 in a private rehabilitation center located in Athens. Only group A followed a program corresponding to a single type of contraction, namely the eccentric one, while group B performed an eccentric-concentric training and group C of eccentricconcentric type associated with the isometric. In all groups, 3 sets of 15 slow and progressive repetitions (associated with stretching before and after treatment) were performed, with increased load at the time when it was possible to perform the exercises in the absence of discomfort. The pain recorded at VAS at the beginning of follow-up was 6.5 cm for the entire sample and at the fourth week there was a decrease of 4 units in all groups with a much greater magnitude of reduction for eccentric-concentric training combined with isometric, compared to eccentric-concentric training (+0.8 VAS units) and eccentric training (+1 VAS unit); this reduction in pain and the improvement of painless grip strength, measured in pounds with a Jamar dynamometer, in favor of the eccentricconcentric exercise group combined with isometric was also confirmed one month after the end of follow-up ($P < .05$). No significant difference was found between eccentric-concentric training and eccentric training with regard to pain (+0.2 vas units, $P > .05$) and gripping force (+3.3 units of painless grip strength, $P > .05$).

In the study of **E. Giray et al. 2019**, with a followup period of 4 weeks, eccentric exercise is associated with stretching and used as the only treatment strategy in group 3, while in group 1 it is associated with kinesiotaping and in group 2 with sham taping. 33 patients were followed on an outpatient basis at a rehabilitation clinic of a university hospital, receiving education, ergonomics advice and instructions on the

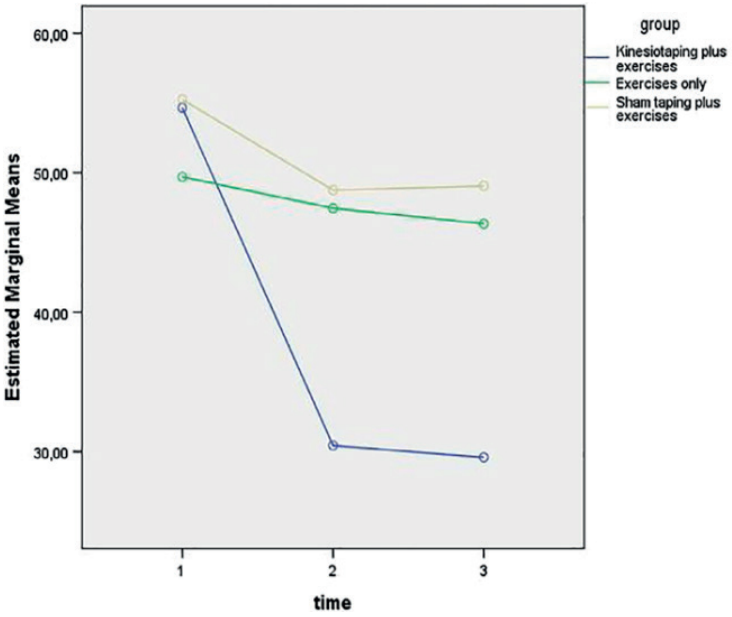
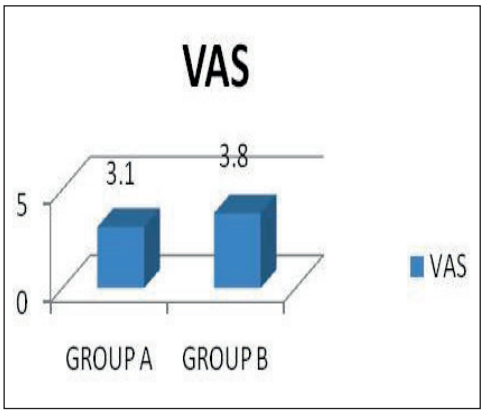


Fig. 4 - PRTEE results during the follow-up

homebased exercise program that included stretching and eccentric reinforcement, as described by Wegener, Eraslan and Struijs et al. The eccentric exercises consisted of: three sets of 10 repetitions for wrist and elbow flexion; two sets of 10 repetitions for the reinforcement of the wrist extenders, starting from 50% of maximum strength and increasing endurance every week, and two series of 10 stretching repetitions (20" stretching and 10" rest) for flexors and wrist extenders. In the kinesiotaping and sham taping groups applications were carried out every 3 days for 2 weeks. Great effects were recorded with respect to the improvement of QuickDASH and PRTEE results (Figure 4) in the kinesiotaping group associated with eccentric exercise and stretching, both post-treatment and at the end of follow-up; VAS at rest, in daily activities and grip strength were statistically significant at the immediate application of the tape (respectively: $P = .041$, $P = .028$, $P = 0017$). Kinesiotaping, in addition to exercises, has been shown to be more effective in terms of pain and disability than sham taping plus exercises and just eccentric exercises with stretching. Among the critical issues of this study, despite the good methodological quality, there are: the small sample of subjects, the impossibility of generalizing this evidence on a population suffering from chronic lateral elbow tendinopathy (only patients with symptoms present for less than 3 months were enrolled) and direct contact with staff only by taping groups.

The multicenter study (involving three centers in Germany specializing in shoulder and elbow), prospective and randomized by **J. Nowotny et al. 2018** analyzed the effectiveness of isometric exercise in association or not with a new dynamic orthosis (CARP-X, Sporlastic) in a population with LET symptoms present for more than three months. The eccentric exercises were performed three times a day for 10 minutes with extended elbow and pronate forearm and with an initial supervision of 6 sessions. At 12 weeks of follow-up, there was a significant decrease in pain on the VAS scale only in the combined treatment group (PT + O group: 6.5–3.7 [$p = 0.001$]; PT: 4.7–4.1 [$p = 0.468$]), but after 12 months this reduction coincided between the 2 groups (PT + O: 1.1 (SD: 1.0) [p =



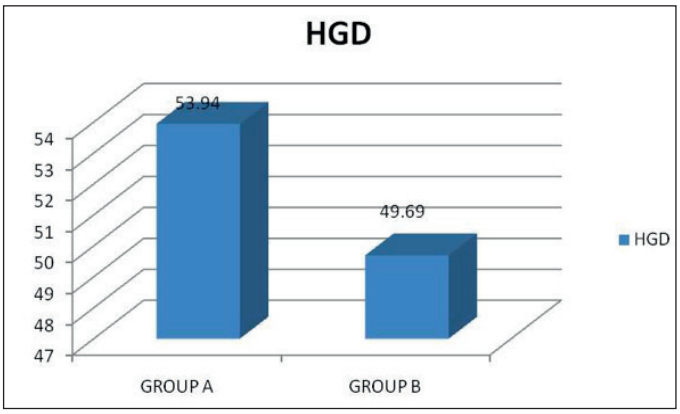


Fig. 5 e 6

0.000]; PT: 1.3 (SD: 1.6) [p = .000]); the maximum pain free force of the hand, assessed with a portable electronic dynamometer (TL-LSC 100, Liteexpress GmbH Coesfeld, Germany), improved in both groups statistically significantly both after 12 weeks (PT + O: 9.9 from (SD: 12.1) to 18.9 (SD: 14) [p = 0.009]; PT: 14.8 (SD: 17.5) to 19.9 (SD: 17.1) [p = 0.031]) than in the 12 months of follow-up (PT + O: 25.3 (SD: 9.3) [p = 0.028]; PT: 32.2 (SD: 15.9) [p = .013]); the maximum grip strength in kg increased only slightly in the PT + O group, while in the physiotherapy group (eccentric exercise only) there was a greater progression both at 12 weeks of follow-up (PT + O: from 20.4 (SD: 16.5) to 20.6 (SD: 12.5) [p = 0.943]; PT: 23.8 (SD: 17.3) to 26.7 (SD: 16.7) [p = 0.051]), than at 12 months (in group PT + O: 26.9 (SD: 9.9) [p = 0.889], in group PT: 33.7 (SD: 14.5) [p = 0.061]). PRTEE scores improved in both groups after 12 weeks (PT + O: 52.8– 31.3 [p = 0.002]; PT: 48.6–37.6 [p = .185]) and at 12 months (PT + O: 16.15 [p = .000]; PT:16.6 [p = .000]), although the reduction at 12 weeks was not significant for the PT group. Elbow flexion was also improved, but without reaching statistical significance, as well as mean supination values, increased in both groups after 12 weeks {PT + O: from 69 (SD: 38) to 86 (SD: 5) [p = 0.073]; PT: 83 (SD: 12) to 86 (SD: 5) [p = .311]} and 12 months {PT + O: 86 (SD: 5) [p = 0.099]; PT: 85 (SD: 5) [p = 0.678]}. The result of this study shows that the daily use of a new wrist orthosis, flexible and dynamic, which puts the wrist extensors muscles in discharge, combined with strengthening eccentric home-based exercise, effectively relieves pain and improves PRTEE scores and grip strength, accelerating the healing process. Among the critical issues of the study are the dropout rate of about 50% at 12 weeks and about 2/3 at 12 months of follow-up, without differences between the two groups, and the heterogeneity of researchers and physiotherapists due to the multicenter approach of the study. The results of the clinical trial of **Viswas et al. 2011** showed that a supervised exercise program (3 times a week for 4 weeks of follow-up) may represent the first treatment choice in the management of LET: group A performed static stretching of the ECRB (extended elbow, pronate forearm and wrist flexion with ulnar deviation) and eccentric strengthening of the wrist extensors, while group B received the Cyriax treatment followed by a Mill manipulation. Stretching was applied depending on the degree of tolerance of the patient and was maintained for 30-45 ‘’ and performed 3 times before and 3 times after eccentric strengthening (3 sets of 10 repetitions performed with extended elbow and pronate forearm, starting from the extension of the wrist; the load was progressively increased according to the abilities of each patient). Although both groups demonstrated a reduction in VAS, it was statistically significant in group A compared to group B; comparison of TEFS scores demonstrated a definitive improvement in functional status at the end of the 4 weeks of supervised exercise compared to Cyriax treatment. Data on the effects of long-term intervention remain unknown and the absence of a true control group and the small sample affect the internal validity of the study.

Rahman et al. 2016 compared for 4 weeks on a sample of 60 patients the effects of a MWM (Mobilization with movement) technique with a supervised exercise program that includes static stretching of the extensor carpi radialis brevis and eccentric strengthening of the wrist extenders. The MWM technique of Lateral Glide was performed in group A with supine subject and pronate forearm, through the use of a strap positioned perpendicular to the forearm and just below the articular line spacing; during the application of the lateral glide by the physiotherapist, each patient was asked to perform the closure of the fist (provocative but painless gesture in the execution of the technique) for 3 sets of 10 repetitions. In the same dose, supervised eccentric exercises (group B) were also proposed, with a progressive increase in load based on 10 RM of each individual patient; the static stretching of the ECRB was performed 3 times before and 3 after the exercises for 30-45 ‘’, respecting the tolerance of each subject. Patients were also provided with education on ergonomics and modification of activities to avoid aggravation of symptoms. At the end of the follow-up, an improvement was recorded in both groups, in particular for group A, both in terms of the grip strength of the HGS hand, evaluated on the first and last day with a handle dynamometer, and for the reduction of the VAS. The post-test analysis of P-value recorded a difference between the 2 groups below 0.01 for VAS and less than 0.02 for HGD.

Considering that during Mulligan’s Mobilization with movement (MWM) techniques there is an integration between physiotherapist’s manual intervention and the isometric muscle activation by the patient (pro-

vocative / limited movement in association with a glide) and that the maintenance of the glide can be prolonged throughout the day through the application of tape and the execution of home exercises (self-glide), it is possible to consider this type of intervention as an "exercise". Paungmali (2004) has shown that MWM techniques produce sufficient sensory inputs to recruit and activate pain-descending inhibition systems and that they generate hypoalgesic effects during and subsequently their application.

The goal of **J.A. Martinez-Silvestrini's 2005** study was to examine the effectiveness of a homebased eccentric exercise program in a population with chronic lateral elbow tendinopathy (>3 months). The sample of 94 subjects was randomly distributed into 3 groups: stretching, eccentric exercise and stretching, concentric exercise and stretching. The eccentric and concentric strengthening groups performed the exercises once a day for 3 sets of 10 repetitions, progressively increasing the resistance of the elastic used. At the end of follow-up (6 weeks) significant improvements (p-value< 0.01) were achieved in all groups, but without a substantial difference between them, in all outcome measures considered: PFG (pain free grip: 0.44), VAS (0.33), PRFEQ (Patient-rated Forearm Evaluation Questionnaire: 0.87) and DASH (0.66).

It is not clear, for the purposes of assessing the methodological quality of that study, what the hidden assignment process was and whether patients and therapists were blinded.

In the prospective trial of **T.L. Sevier and C.W. Stegink-Jansen 2015**, with a two-group parallel drawing, held in Indiana (USA), subjects with chronic LET were randomly assigned to a treatment group with Astym or with an eccentric exercise program for a follow-up period of 4 weeks, followed by a 'confirmation period' of another 4 (no intervention delivered) in which the effects of the two proposals were observed Therapeutic. An Astym treatment specialist delivered a protocol that also included the combination of stretching and eccentric exercise, also performed by the other group in the same dose and modality. 78.3% (36/46) of patients in the Astym group responded by meeting the resolution criteria from initial treatment at 4 to 8 weeks (after the confirmation period); in the other group (eccentric exercise and stretching) 40.9% (18/44) of patients met the resolution criteria at 4 weeks or 8 weeks. In the observational phase, a subject in the Astym group opted to receive EE, without further resolution of symptoms. Of the 26 non-responder patients in the EE group, 21 chose to receive Astym treatment for one month at 8 weeks of follow-up, after which 20 (95.7%) met the resolution criteria. Thus, of the 67 cases treated with Astym therapy (initial or delayed) 56 of them (83.6%) met the resolution criteria, recording a significant improvement in the measures of DASH outcome (0.047) and maximum grip force (0.008) compared to the eccentric exercise group; there was no noticeable difference between the 2 groups regarding VAS in terms of pain and VAS regarding function. It was surprising to note that long-term follow-up revealed that these subjects retained the benefits at 6 and 12 months, and that patients who took Astym treatment late achieved the same results as those in the initial group. From this study it has been shown that the stimulation given by physical pressure and shear forces, associated with a specific tendon load (EE and stretching), gives greater benefits than a program of only eccentric exercises and stretching. **3.4.3**

Concentric Exercise

In two previously analyzed papers, it was also examined concentric exercise (in association or not with stretching) in the treatment of chronic LET: the Swedish study conducted by **Peterson et al. 2014** showed an improvement also by the group of concentric home exercises at the twelfth week of follow-up both with regard to pain at MCV (Maximum Voluntary Contraction) and pain at MME (Maximum Muscle Elongation); however, there were no significant differences with the group of eccentric exercises in the regime applied at home for all other outcome measures assessed at the beginning of follow-up, at 3, 6 and 12 months (DASH and Gothenburg Quality of Life instrument). Chronic LET responded more favorably to a gradual eccentric exercise program rather than a concentric one. Both are valid methods of intervention, of simple execution, but it has emerged that eccentric work has provided greater advantage; in the work of **J.A. Martinez-Silvestrini** et al. 2005 no statistically relevant difference was shown at the end of the follow-up between the 3 groups under study, however the eccentric exercise associated with stretching also presented remarkable results (p-value < 0.01) in the outcome measures examined (PFG, VAS, PRFEQ, DASH).

Stretching

In many of the considered jobs stretching has been a mode of intervention often combined with other types of exercise. Stretching was considered as monotreatment in 2 Rct:

- the results of the stretching group coincide with those of the other groups considered in the study by **J.A. Martinez-Silvestrini et al. 2005**. All recruited subjects were instructed on stretching the wrist extenders in an upright position, with shoulder flexed at 90°, extended elbow and wrist flexion (3 repetitions with 30' tightness performed 2 times a day). It is also essential to remember that all the patients examined have received stretching, education and have used ice, which is why it is not possible to exclude the influence of these interventions on the conspicuous benefits obtained by the 3 groups;
- in the prospective, randomized and controlled, but not blinded, trial of **Nishizuka et al. 2016** the goal was to evaluate the effectiveness of an orthosis for the forearm in LET worn for more than 6 hours a day for 6 months in association with the stretching of the wrist extenders, also performed by the other group (30'' held performed 3 times a day for 6 months). At one month of follow-up Hand- 10 scores tended to be lower in the orthosis group, however no statisticallysignificant difference was found between the 2 groups at 1, 3, 6 and 12 months regarding improved outcomes: palpation pain, Thomsen test positivity, middle finger extension and satisfaction levels. In conclusion, the recorded results suggest that the forearm orthosis may have no more than a placebo effect compared to stretching exercises.

Exercises Of Various Types Compared With

Low-Energy Shock Waves

The randomized controlled trial by **B. Sarkar et al. 2013** was designed to evaluate in LET's treatment the effectiveness of low-energy shock waves (2000 pulses of 0.06 mJ / mm2) delivered by means of an experimental device (model MP-100 Storz Medical, Ta gerwilen, Switzerland), associated with a supervised therapeutic exercise protocol (treatment delivered to group A once a week for 3 weeks); control group B performed a supervised exercise protocol 3 times a week and both groups were instructed to perform a home exercise program 2 times a day for 4 weeks. The supervised exercise program included isometric, concentric and eccentric contractions associated with stretching, performed 3 times before and after the exercises. At the fourth week of follow-up, a significant reduction in pain was recorded in both groups ($p < 0.001$) and group A reported a significantly lower VAS score than group B. Pain free grip strength (assessed with modified sphygmomanometer) was also significantly improved at the fourth week in both groups ($p < 0.05$), with greater relevance in group A, but without full achievement of statistical significance ($p > 0.025$); similarly, both groups demonstrated improvements in hand function (DASH) and group A scored significantly lower than group B at the end of follow-up ($p = 0, 001$).

The results of the study showed that a combination of low-energy extracorporeal shockwave therapy and therapeutic exercise brought greater benefits in all outcome measures considered, compared to the exercise program alone; despite this, it is necessary to note the small size of the sample examined (30 participants) which could explain the non-significant difference between the 2 groups in grip strength after treatment and the knowledge by the evaluator of the group to which the patients belong that may have influenced the outcomes of the study.

DISCUSSION

The objective of the review is to define the role of therapeutic exercise in the management of patients suffering from lateral elbow tendinopathy and to answer the aforementioned clinical question considering the eligibility criteria of studies focused on different populations for the time of onset of symptoms. All the included trials accurately delineate the dosage, type and mode of intervention for each type of therapeutic exercise and, most of them, measured the effectiveness of the results through scales that took into account pain or perceived disability and dynamometric evaluations of the grip strength: numerous studies confirm the finding of the post-exercise improvement of this outcome measure. Many studies have stated that physical exercise is an effective treatment for tendinopathies, such as to represent the key element in the rehabilitation process of the aforementioned tendinopathy, often addressed in a multimodal approach. Although its use in lateral elbow tendinopathy is recommended, scientific research is still trying to understand what may be the most effective type of therapeutic exercise for LET. From the review carried out all the studies, albeit with their methodological limitations, have shown an important effectiveness of the proposed treatments: therapeutic exercise has been found to be the safest, cheapest and most efficient means to obtain a significant clinical improvement of outcomes. Despite the heterogeneous evidence of effectiveness, in the light of what has emerged, it is possible to consider all types of muscle contraction valid. The isometric exercise outlined in the home-based programs has demonstrated a reduction in pain and disability in the short term in subjects with symptoms present for at least 6 weeks: recently isometric contraction has been outlined as beneficial in the management of tendon pain; Rahman et al. showed a prevalent improvement in VAS and grip strength in patients who performed isometric contractions associated with the glide delivered by the therapist compared to the eccentric exercise and stretching group: Miller (2000) described in his case report the use of MWM for the treatment of TLG with consequent reduction of pain, improvement of gripping strength and greater ability to tolerate resisted isometric extension of the wrist. Eccentric exercise was the most contemplated and revealed encouraging results in terms of pain reduction and improvement of maximum grip strength: although the literature is limited, eccentric programs are varied and the optimal dosage has not yet been defined. The exact mechanisms by which eccentric exercises are effective in the treatment of tendinopathy remain unclear, there seems to be a significant change in tendon structure, but the clinical meaning has not been determined. The results highlight heterogeneous evidence of efficacy: Dimitrios and Ioannis Stasinopoulus compared the effectiveness of eccentric training with other combinations of it and it followed that the eccentric- concentric training associated with isometric exercise achieved the greatest effect in terms of pain reduction and improvement of function; Peterson et al. demonstrated the rapid achievement of results compared to the group of concentric exercises in patients with chronic LET through a 3-month eccentric training at home; the work of Viswas et al. found the greater effectiveness of a supervised program of eccentric exercise associated with stretching than deep transverse massage but, on the contrary, in the study of T. L. Sevier and C.W. Stegink-Janse, it seems that only eccentric exercise with stretching is no better than the passive mobilization of soft tissues associated with them. In general, these studies support the hypothesis that a physiotherapeutic approach with eccentric exercises has a positive impact on the resolution of lateral elbow tendinopathy, as it allows to reduce the painful symptom in the short term and to improve grip strength. Although stretching is most often used together with other types of exercise, it has been found in any case a valid therapeutic strategy, as it favors the alignment of collagen fibers and enhances tensile tendon strength; strengthening exercises, on the other hand, reduce the load forces transferred to the joint and with the increase in tone-trophism allow at the same time their greater absorption.

Limitations Of The Review Process

The main limitations of the review are to be found in the heterogeneity of the trials included for the type of treatment administered, the size of the samples and the type of outcomes considered; in addition, many of the works collected have often compared multiple types of exercise with another treatment affecting the possibility of making clear the actual benefit of the single exercise. Only in the study of Vincenzino et al. a real placebo control group was used, unlike all

the other works, thus making it almost impossible to settle between the real effects and the effectiveness of the individual treatments and determine, therefore, which was the best. In addition, it's not possible to generalize the results detected, as the articles' heterogeneity inserted is also linked to the selection criteria of the patients, in particular the age, severity and duration of the symptoms that change from study to study: when the symptoms become persistent also the psycho-social factors can contribute to the slowing down of the recovery path and impact, consequently, on the effectiveness of training. Multicenter studies were also presented that may have drawn influences from the therapeutic approaches provided at the different recruited facilities and, only in a few cases, long-term data were collected, in order to observe the possible persistence over time of the positive evolution of the symptoms.

CONCLUSIONS

The present work has tried to answer the clinical question focused on the real effectiveness of therapeutic exercise in the management of patients with lateral elbow tendinopathy. From the inclusion criteria of the different studies it has been found that the pain free grip strength is often reduced in patients suffering from LET, so asking during physiotherapy treatment to clench the fist would exacerbate the pain that could persist even after the session: working on the grip strength in a non-painful ROM seems to be the best solution and has proven to be a valid clinical measure, reliable and sensitive to monitor the progress of rehabilitation. Patients with LET have also been shown to grip their wrists with greater flexion, which could be the cause of increased ECRB compression.

There is a level of evidence 1 and a good quality regarding the multimodal management of this pathological condition, focusing on education, recovery times, the principle of load management and shared decision-making, so that the patient takes an active role in his rehabilitation, crucial for the construction of an effective management system of lateral elbow tendinopathy. Multimodality of treatment should be present within a multidimensional system, based on therapeutic exercise, that provides treatment in a biopsychosocial perspective. In the context of LET rehabilitation, the advantages of the exercises detected were: greater and rapid decrease in pain, reduction of medical visits, increase in working capacity and less absenteeism at work. Despite the obvious benefits, the optimal intensity, duration and frequency or the precise type of load to rehabilitate this patient population is not known.

The results of the different studies that investigated therapeutic exercise are different and inconsistent, there does not seem to be a panacea. Eccentric exercises have been the most studied and are the most popular choice of exercise, yet it is not consistently better than other types. Given the heterogeneity of the clinical presentation, it is likely that the optimal modalities and doses of the exercises vary from patient to patient, depending on the stage of the pathology. At the moment there is a debate about the execution of the exercise, in particular whether the load on the tendon should be painful or not to produce optimal results. A systematic review by Ben Smith et al. 2018 showed that exercises that cause less pain appear to have short-term efficacy in patients with chronic musculoskeletal pain, but there are no differences in the medium and long term between painful and non-painful exercise; despite this, in relation to the elbow, most of the evidence suggests pain- free exercises, but there are no randomized clinical trials that compare painful to non-painful exercises that can guide in the clinical setting. Although the critical evaluation of the studies did not reveal a low methodological quality and information regarding the performance characteristics of the exercise was often described, it was not possible to draw a clear and exhaustive conclusion of the evidence. The comparison that has been made with other treatments has not produced any definitive result of statistically and / or clinically significant superiority, since, although reporting an important improvement in pain intensity, strength and disability, it is not possible to define any prevalence of effectiveness between one type of exercise and another, also because they are often combined.

Therefore, homogeneous studies are desirable in the future that compare therapeutic exercise with a real placebo treatment, recruiting larger and different types of patients's cohorts of with LET, so as to be able to transfer the results to the general population and better direct clinical practice in the management of this tendinopathy. Although further work of good methodological quality is confirmed to be necessary to define the optimal dosage and the detailed methods of execution aimed at maximizing recovery, the results allow to have a useful overview on the use of therapeutic exercise in lateral elbow tendinopathy and provides interesting ideas to produce new studies on the subject.

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