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Lateral Elbow Pain and Muscle Function Impairments

Clinical Practice Guidelines Linked to the International Classification of Functioning, Disability and Health from the Academy of Hand and Upper Extremity Physical Therapy and the Academy of Orthopaedic Physical Therapy of the American Physical Therapy Association

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Summary of Recommendations*

OUTCOME, ACTIVITY LIMITATIONS, SELF-REPORT MEASURES

A Clinicians should use the diagnosis-specific Patient-Rated Tennis Elbow Evaluation (PRTEE) to assess pain/irritability and function and/or the region-specific Disabilities of the Arm, Shoulder and Hand (DASH) to assess upper extremity function at baseline and at least one other follow-up point that includes discharge for individuals with lateral elbow tendinopathy (LET).

A Clinicians should use the Patient-Specific Functional Scale (PSFS) for patients with high-demand activities and/or should administer a scale that assesses activity-specific disability (eg, DASH work or sports/performing arts module) at baseline and at least one other follow-up point that includes discharge for individuals with LET.

PHYSICAL IMPAIRMENT MEASURES

B Clinicians should include the physical impairment measures of elbow and wrist range of motion, pressure pain threshold, pain-free grip strength, and maximum grip strength at baseline and at least one other follow-up point that includes discharge for individuals with LET.

INTERVENTIONS: THERAPEUTIC EXERCISE

B Clinicians should use isometric, concentric, and/or eccentric therapeutic resisted exercises of the wrist extensors in the treatment of individuals with subacute or chronic LET.

F Clinicians may use a phased approach to reintroduce stress, increase strength, improve endurance, and restore optimal motor control in individuals who have LET symptoms with high-demand occupations, hobbies, performing arts, or athletic interests.

MULTIMODAL INTERVENTIONS: INCLUDING THERAPEUTIC EXERCISE

B Clinicians should use therapeutic resisted wrist extension strengthening exercises in combination with other therapeutic interventions, including manual therapy, in the treatment of patients with subacute or chronic LET.

C Clinicians may include shoulder and scapular stabilizer muscle training exercises, when impairments are identified, in conjunction with other forms of wrist extensor strengthening exercise in individuals with LET.

INTERVENTIONS: MANUAL THERAPY JOINT MOBILIZATIONS/MANIPULATIONS

B Clinicians should use local elbow joint manipulation or mobilization techniques to reduce pain and increase pain-free grip strength in individuals with LET, as a stand-alone or adjunctive treatment in improving short-term outcomes for those who can tolerate the specific technique.

C Clinicians may use manipulation or mobilization techniques directed at the cervical spine, thoracic spine, and/or wrist as an adjunct to local treatment for short-term pain relief in individuals with LET when impairments in those regions are identified.

INTERVENTIONS: MANUAL THERAPY SOFT TISSUE MOBILIZATION

C Clinicians may use soft tissue mobilizations, including manual release therapy, to improve pain and function in individuals with chronic LET.

C Clinicians may use instrument-assisted soft tissue mobilization combined with exercise to improve pain and function in those with chronic LET.

D Based on conflicting evidence, a recommendation cannot be made regarding the use of deep transverse tendon cross-friction massage to alleviate symptoms in individuals with LET.

INTERVENTIONS: DRY NEEDLING

B Clinicians should use either tendon or trigger point dry needling for the treatment of pain and functional deficits associated with LET.

INTERVENTIONS: ORTHOSES

D Based on conflicting evidence, a recommendation cannot be made regarding the use of a forearm counterforce or wrist support orthosis to alleviate intermediate or long-term symptoms in individuals with LET.

F Clinicians may use a forearm counterforce or wrist support orthosis to be worn during activity for immediate improvement of pain and strength in those with LET whose symptoms are aggravated with activity.

INTERVENTIONS: TAPING

B Clinicians should use rigid taping techniques for immediate/short-term pain relief and improvement in pain-free muscle function in those with irritable LET.

C Clinicians may use kinesiology tape application as part of a multimodal treatment program for immediate and short-term management of pain and muscle function in individuals with LET.

INTERVENTIONS: CRYOTHERAPY

C Clinicians may use cryotherapy combined with burst transcutaneous electrical nerve stimulation (TENS) to reduce pain in the short term in individuals with symptoms of LET for greater than 30 days.

E Clinicians may use cryotherapy to reduce pain in individuals with irritable symptoms of LET.

INTERVENTIONS: THERAPEUTIC ULTRASOUND

D Based on conflicting evidence, a recommendation cannot be made for the use of ultrasound as a stand-alone treatment.

INTERVENTIONS: PHONOPHORESIS

C Clinicians should not use phonophoresis with 10% hydrocortisone gel, topical prednisolone (2 mg/d), or 1% diclofenac sodium gel for the treatment of LET.

INTERVENTIONS: IONTOPHORESIS

C Clinicians may use iontophoresis with an anti-inflammatory drug, early in the rehabilitation phase (no later than 2-4 weeks from onset or aggravation of symptoms), in individuals presenting with highly irritable symptoms of LET.

INTERVENTIONS: TENS

C Clinicians may use burst TENS applied to the painful region or high- or low-frequency TENS applied to acupuncture points, for short-term pain relief in individuals with LET.

INTERVENTIONS: LASER

C Clinicians may use laser therapy for improvements in pain and grip strength, seen in follow-up periods >4 weeks to 6 months, for individuals with LET.

INTEREVENTIONS: ERGONOMICS

E Clinicians may use ergonomic interventions in the management of symptoms in individuals with LET; the implementation of education, behavioral modification, ergonomic equipment, and workstation adjustments is moderately supported by best practice/standard of care.

*These recommendations and clinical practice guidelines are based on the scientific literature published prior to November 2021.

List of Abbreviations

AHUEPT: Academy of Hand and Upper Extremity Physical Therapy
APTA: American Physical Therapy Association
ANOVA: analysis of variance
AOPT: Academy of Orthopaedic Physical Therapy
CI: confidence interval
CPG: clinical practice guideline
DASH: Disabilities of the Arm, Shoulder and Hand
DFM: deep friction massage
ECRB: extensor carpi radialis brevis
ES: effect size
GCS: Global Change Scale
GROC: Global Rating of Change
HADS: Hospital Anxiety & Depression Scale
HILT: high-intensity laser therapy
ICC: intraclass correlation coefficient
ICD: International Classification of Diseases
ICF: International Classification of Functioning, Disability and Health
***JOSPT*:** Journal of Orthopaedic & Sports Physical Therapy
LET: lateral elbow tendinopathy
LILT: low-intensity laser therapy
MCID: minimal clinically important difference
MD: mean difference
MDC: minimal detectable change
MEPI: Mayo Elbow Performance Index
MRI: magnetic resonance imaging
MRT: manual release therapy
MVIC: maximum voluntary isometric contraction
MWM: mobilization with movement
NPRS: numeric pain-rating scale
OR: odds ratio
PE: percutaneous electrolysis
PFGS: pain-free grip strength
PPT: pressure pain threshold
PRFEQ: Patient-Rated Forearm Evaluation Questionnaire
PROM: patient-reported outcome measure
PRTEE: Patient-Rated Tennis Elbow Evaluation
PRWE: Patient-Rated Wrist Evaluation
PSFS: Patient Specific Functional Scale
RCT: randomized clinical trial
RM: Score: Roles and Maudsley Score

ROM: range of motion
RR: relative risk
SD: standard deviation
SEM: standard error of measurement
SMD: standardized mean difference
SRM: standardized response mean
TDN: trigger point dry needling
TENS: transcutaneous electrical nerve stimulation
UE: upper extremity
US: ultrasound
VAS: visual analog scale
WMD: weighted mean difference
W/cm²: Watts per centimeter squared

Introduction

AIM OF THE GUIDELINES

The Academy of Hand and Upper Extremity Physical Therapy (AHUEPT) and Academy of Orthopaedic Physical Therapy (AOPT) of the American Physical Therapy Association (APTA) have an ongoing effort to create evidence-based practice guidelines for management of patients with musculoskeletal impairments described in the World Health Organization's International Classification of Functioning, Disability and Health (ICF).[204]

The purposes of these clinical guidelines are to:

- Describe evidence-based practice including diagnosis, prognosis, intervention, and assessment of outcomes of musculoskeletal disorders commonly managed by orthopaedic, sports, and hand physical therapists
- Classify and define common musculoskeletal conditions using the World Health Organization's terminology related to impairments of body function and body structure, activity limitations, and participation restrictions
- Identify interventions supported by current best evidence to address impairments of body function and structure, activity limitations, and participation restrictions associated with common musculoskeletal conditions
- Identify appropriate outcome measures to assess changes resulting from physical therapy interventions in body function and structure as well as in activity and participation of the individual
- Provide a description to policy makers, using internationally accepted terminology, of the practice of orthopaedic, sports, and hand physical therapists
- Provide information for payers and claims reviewers regarding the practice of orthopaedic, sports, and hand therapy for common musculoskeletal conditions
- Create a reference publication for clinicians, academic instructors, clinical instructors, students, interns, residents, and fellows regarding the best current practice of orthopaedic and sports physical therapy and hand rehabilitation

STATEMENT OF INTENT

These guidelines are not intended to be construed or to serve as a standard of medical care. Standards of care are determined on the basis of all clinical data available for an individual patient and are subject to change as scientific knowledge and technology advance and patterns of care evolve. These parameters of practice should be considered guidelines only. Adherence to them will not ensure a successful outcome in every patient, nor should they be construed as including all proper methods of care or excluding other acceptable methods of care aimed at the same results. The ultimate judgment regarding a particular clinical procedure or treatment plan must be made in light of the clinical data presented by the patient, the diagnostic and treatment options available, and the patient's values, expectations, and preferences. However, we suggest that significant departures from accepted guidelines should be documented in the patient's medical records at the time the relevant clinical decision is made.

SCOPE AND RATIONALE OF THE GUIDELINE

Lateral elbow tendinopathy (LET) is characterized by pain at the common wrist extensors at or near the lateral epicondyle that is aggravated by loading of the involved muscles.[13] The extensor carpi radialis brevis (ECRB) and extensor digitorum muscles are the most frequently injured,[16] while the pain is believed to originate from excessive tensile force on the injured musculotendinous structures and periosteal junction. Lateral elbow tendinopathy is commonly known as tennis elbow, yet despite the name, many individuals who present with symptoms of LET are not involved in racquet sports.[193] Athletes of all types and individuals who repetitively use their upper extremity (UE), particularly involving their wrist extensors, can be at risk for developing LET. Although many describe the condition as self-limiting and likely to resolve on its own, high recurrence rates and extended sick leave highlight the challenge for the nonsurgical management of individuals with LET.[14,22] Therefore, there is a need to assemble a comprehensive set of guidelines for assessing and treating LET.

As the understanding of the histology underpinning the tendon pathology associated with LET has evolved, clinicians are beginning to recognize the complexity of the diagnosis. The interrelationship of histological and structural changes to the tendon itself, the associated impairments in motor control, and potential changes in pain processing can all contribute to the presentation of symptoms in any given individual.[36,59]

This clinical practice guideline (CPG) includes studies reporting on LET pertinent to physical therapist practice. Epidemiology, functional anatomy and pathophysiology, risk factors, clinical course, prognosis, differential diagnosis, tests and measures, and interventions are included. This CPG excluded studies that addressed pathologies closely related to LET. For example, cervical radiculopathy, primary peripheral nerve entrapment, and joint pathology including plica syndrome, radiocapitellar chondromalacia, and posterolateral rotatory instability as causes of lateral elbow pain were excluded. Finally, this CPG excluded interventions outside the scope of physical therapist practice including but not limited to pharmacological and surgical interventions unless directly compared to physical therapy management.

Methods

The AHUEPT and the AOPT of the APTA appointed content experts to develop CPGs for musculoskeletal conditions of elbow, forearm, wrist, and hand. The aims of this review were to provide a concise summary of the contemporary evidence and to develop recommendations to support evidence-based practice. The authors of this guideline worked with the CPG editors and medical librarians for methodological guidance. One author (R.L.M.) served as the team's methodologist. Research librarians were chosen for their expertise in systematic review and rehabilitation literature searching and to perform systematic searches for concepts associated with classification, examination, and intervention strategies for LET. Briefly, the following databases were searched between January 2001 to November 2021: PubMed including Medline, CINAHL, and the Cochrane Library (see **APPENDIX A** for full search strategies, dates, and results, available at www.jospt.org and www.handpt.org).

The authors declared relationships and developed a conflict management plan, which included submitting a conflict-of-interest form to the AOPT. Articles authored by members of the CPG team were assigned to an alternate reviewer. The AOPT and AHUEPT funded the CPG development team for travel and CPG development training. The CPG development team maintained editorial independence with regards to the funding agencies.

Articles contributing to recommendations were reviewed based on prespecified inclusion and exclusion criteria with the goal of identifying evidence relevant to physical therapist clinical decision-making for adults with LET. Two members of the CPG development team independently screened the title and abstract prior to full text review to obtain the final set of articles used to make the recommendations. (See **APPENDIX B** for inclusion and exclusion criteria, available at www.jospt.org and www.handpt.org.) The team leader (A.M.L.) provided the final decision for discrepancies that were not resolved by the review team (see **APPENDIX C** for the flowchart of articles, available at www.jospt.org). Data extraction and assignment of level of evidence was also performed and were confirmed by members of the CPG development team. For selected relevant topics for which recommendations were not developed, which included incidence, risk factors, differential diagnosis, imaging, and prognosis, articles were not subject to systematic review process and were not included in the flowchart. Evidence tables for this CPG are available on the CPG page of the AOPT of the APTA websites: www.orthopt.org and www.handpt.org.

This guideline was issued in 2022, based on the published literature from January 2001 to November 30, 2021, and will be considered for review in 2027, or sooner if important evidence becomes available. Any updates to the guideline in the interim period will be noted on the AOPT and AHUEPT of the APTA websites: www.orthopt.org and www.handpt.org.

LEVELS OF EVIDENCE

Individual clinical research articles were graded according to criteria adapted from the Centre for Evidence-Based Medicine, Oxford, UK (http://www.cebm.net)[25] for diagnostic, prospective, and therapeutic studies. In teams of 2, each reviewer independently assigned a level of evidence and evaluated the quality of each article using a critical appraisal tool. If the 2 reviewers did not agree on levels of evidence for a particular article, a third content expert was used to resolve the issue. (See **APPENDICES D** and **E** for Levels of Evidence table and details on procedures used for assigning levels of evidence, available at www.jospt.org and www.handpt.org.) The evidence was organized from the highest to lowest level of evidence. An abbreviated version of the grading system is provided in **TABLE 1.**

TABLE 1 Levels of Evidence

I	Evidence obtained from high-quality diagnostic studies, prospective studies, systematic reviews, or randomized controlled trials
II	Evidence obtained from lesser-quality diagnostic studies, systematic reviews, prospective studies, or randomized controlled trials (eg, weaker diagnostic criteria and reference standards, improper randomization, no blinding, <80% follow-up)
III	Case-controlled studies or retrospective studies
IV	Case series
V	Expert opinion

GRADES OF EVIDENCE

The overall strength of the evidence supporting recommendations made in these guidelines was graded according to guidelines described by Guyatt et al,[66] as modified by MacDermid[114] and adopted by the coordinator and reviewers of this project. In this modified system, the typical A, B, C, and D grades of evidence have been modified to include the role of consensus expert opinion and basic science research to demonstrate biological or biomechanical plausibility (**TABLE 2**). In developing their recommendations, the authors considered the strengths and limitations of the body of evidence and the health benefits, side effects, and risks of tests and interventions.

GUIDELINE REVIEW PROCESS AND VALIDATION

Identified reviewers who are experts in UE injury management and rehabilitation reviewed a prepublication draft of this CPG content and methods for integrity, accuracy, and that it fully represents the condition. Any comments, suggestions, or feedback from the expert reviewers were delivered to the author and editors for consideration and appropriate revisions. These guidelines were also posted for public comment on the AOPT website (www.orthopt.org), and a notification of this posting was sent to the members of the AOPT and AHUEPT. Any comments, suggestions, and feedback gathered from public commentary were sent to the authors

TABLE 2 Grades of Recommendation

Grades of Recommendation		Strength of Evidence	Level of Obligation
A	Strong evidence	A preponderance of level I and/or level II studies support the recommendation. This must include at least 1 level I study	Must or should
B	Moderate evidence	A single high-quality randomized controlled trial or a preponderance of level II studies support the recommendation	Should
C	Weak evidence	A single level II study or a preponderance of level III and IV studies, including statements of consensus by content experts, support the recommendation	May
D	Conflicting evidence	Higher-quality studies conducted on this topic disagree with respect to their conclusions. The recommendation is based on these conflicting studies	
E	Theoretical/foundational evidence	A preponderance of evidence from animal or cadaver studies, from conceptual models/principles or from basic sciences/bench research, supports this conclusion	May
F	Expert opinion	Best practice based on the clinical experience of the guideline development team	May

TABLE 3 Planned Strategies and Tools to Support the Dissemination and Implementation of This CPG

Tool	Strategy
JOSPT's "Perspectives for Patients" and "Perspectives for Practice" articles	Patient- and clinician-oriented guideline summaries available at www.jospt.org
Mobile app of guideline-based exercises for patients/clients and health care practitioners	Marketing and distribution of app via www.orthopt.org and www.handpt.org
Clinician's Quick-Reference Guide	Summary of guideline recommendations available at www.orthopt.org and www.handpt.org
JOSPT's Read for Credit℠ continuing education units	Continuing education units available for physical therapists at www.jospt.org
Webinars and educational offerings for health care practitioners	Guideline-based instruction available for practitioners at www.orthopt.org and www.handpt.org
Mobile and web-based app of guideline for training of health care practitioners	Marketing and distribution of app via www.orthopt.org
Non-English versions of the guidelines and guideline implementation tools	Development and distribution of translated guidelines and tools to JOSPT's international partners and global audience via www.jospt.org
APTA CPG+	Dissemination and implementation aids

Abbreviations: APTA, American Physical Therapy Association; CPG, clinical practice guideline.

and editors to consider and make appropriate revisions in the guideline. In addition, a panel of consumer/patient representatives and external interested parties, such as claims reviewers, medical coding experts, academic educators, clinical educators, physician specialists, and researchers, also reviewed the guideline and provided feedback and recommendations that were given to the authors and editors for further consideration and revisions. The AOPT Clinical Practice Guideline Advisory Panel reviews guideline development methods, policies, and implementation processes on a yearly basis.

DISSEMINATION AND IMPLEMENTATION TOOLS

In addition to publishing these guidelines in the Journal of Orthopaedic & Sports Physical Therapy (*JOSPT*), these guidelines will be posted on CPG (free access) areas of the *JOSPT*, AOPT, and AHUEPT websites and submitted to be available for free access on the ECRI Guidelines Trust (guidelines.ecri.org) and the Physiotherapy Evidence Database (www.PEDro.org.au). The planned implementation tools for patients, clinicians, educators, payers, policy makers, and researchers, and the associated implementation strategies are listed in **TABLE 3**.

ORGANIZATION OF THE GUIDELINE

When systematic reviews were conducted to support specific actionable recommendations, summaries of studies with the corresponding evidence levels were followed by evidence synthesis and rationale for the recommendation(s) with harms and benefits statements and gaps in knowledge. Topics for which a systematic review was conducted and recommendations provided include patient-reported outcome measures (PROMs), physical impairment measures, and interventions. For other topics where a systematic review was outside the scope of this CPG, a summary of the literature is provided. This includes incidence/prevalence, pathoanatomical features, risk factors, clinical course, prognosis, diagnostic classification, and differential diagnosis, and imaging.

CLASSIFICATION

The primary International Classification of Diseases 10th Revision (ICD-10) codes and conditions associated with lateral elbow pain and muscle function impairments (LET) are outlined in **TABLE 4**.

TABLE 4 ICD and ICF Codes Associated With Lateral Elbow Pain

International Statistical Classification of Diseases and Related Health Problems (ICD-10) 2015		
ICD-10	M77.1	Lateral epicondylitis

International Classification of Functioning, Disability and Health (ICF)	
ICF Codes	**Description**
Muscle Function Impairments	
b730-b74	Muscle functions
b730	Muscle power functions
b7300	Power of isolated muscles and muscle groups
b7301	Power of muscles of one limb
b740	Muscle endurance functions
b7400	Endurance of isolated muscles
b7401	Endurance of muscle groups
Pain	
b280	Sensation of pain
b28014	Pain in upper limb
Motor Control Impairments	
b1471	Quality of psychomotor functions
b760	Control of voluntary movement functions
b7602	Coordination of voluntary movements
b7603	Supportive functions of arm or leg
Activity Limitations	
d445	Hand and arm use
d4453	Turning or twisting the hands or arms
d430	Lifting and carrying objects
d4300	Lifting
d440	Fine hand use
d4400	Picking up
d4454	Throwing
Participation Restrictions	
d920	Recreation and leisure
d9201	Sports
d840-d859	Work and employment
d850	Remunerative employment
d8500	Self-employment
d8501	Part-time employment
d8502	Full-time employment
d855	Nonremunerative employment

Abbreviations: ICD, International Classification of Diseases; ICF, International Classification of Functioning, Disability and Health.

CLINICAL PRACTICE GUIDELINES

Impairment/Function-Based Diagnosis

PREVALENCE/INCIDENCE

A large population-based study suggested an overall annual incidence of LET in the United States of 3%, although the rates for those 40-60 years old were higher, ranging between 7% and 10%.[158] The prevalence of LET has been reported to be as high as 29% in workers in occupations that required a high demand of wrist and hand movements.[170,198] A 2015 systematic review of UE work-related musculoskeletal disorders reports LET incidence ranges from 0.45 to 7 new cases per 100 workers and prevalence ranges from 1 to 12.2 new cases per 100 workers.[40] An average of 12 weeks of sick leave from work is taken in approximately 30% of those individuals with LET.[13,17] Additionally, incomplete resolution or recurrence of symptoms at 6-12 months in individuals receiving local nonsurgical management has been shown to range between 20% and 38%.[16] At 2 years follow-up, the rate of recurrence has been shown to be as high as 54%.[134] In tennis players, the 2-month prevalence has been reported at 14%, with recurrent cases being more common than new cases, and rates increasing in players over 40 years of age.[65] A twin study estimated that heritability was 40%, after adjusting for age.[197]

Pathoanatomical Features

The lateral epicondyle of the humerus, located just above the capitellum, is the origin of the extensor-supinator muscles.[126,130] The most common site of pathology in LET is the juncture of the common extensor muscle origin of the lateral epicondyle.[99] The enthesis or insertion of the common extensor tendon is characterized by a load sharing mechanism where fibers of the ECRB tendon fuses with the lateral collateral ligament of the elbow and joint capsule and subsequently with the annular ligament of the proximal radial ulnar joint.[125] Stress is dissipated throughout the entire enthesis organ and may explain the somewhat diffuse distribution of pain at the lateral elbow with LET.[12]

The common extensor tendon of the wrist and fingers at the elbow may be injured not only by repetitive tensile loading but also by shearing forces against the capitellum with forearm rotation.[23] The ECRB tendon has a unique anatomic location that makes its undersurface vulnerable to contact and abrasion against the lateral edge of the capitellum during forearm pronation and supination.[275] Relative hypovascularity of the ECRB tendon may further contribute to the susceptibility of the tendon to injury and may negatively impact healing.[8,161] The extensor carpi radialis longus and extensor digitorum tendons may also be involved. This may explain why repetitive loading of the elbow, forearm, wrist, and/or digits during work or athletic activities increases the risk of LET.[48,171] However, similar biomechanical loading can potentially injure adjacent structures; therefore, a thorough examination is required to differentiate lateral elbow pain caused by tendinopathy from other sources of symptoms such as muscle, joint, or nerve pathology.

There has been a shift in understanding of tendon pathology over the past 20 years. Tendinopathy refers to a nonrupture injury in the tendon or peritendon (paratenon and epitenon) that is aggravated by mechanical loading.[62] The term tendinitis characterizes an acute condition with a cell-mediated inflammatory response. Tendinosis is a term that has been used to describe chronic degenerative tendon pathology, characterized by an abundance of fibroblasts, vascular hyperplasia, and unstructured collagen. Over time, clinical terminology has changed from tendinitis or tendinosis to tendinopathy, which represents the pain and impaired muscle function related to a broad spectrum of potential intratendinous changes in structure, histology, and chemical mediators of pain and/or inflammation.[58] In those with LET, as with other forms of tendinopathy, individuals present somewhere in the continuum between acute and chronic conditions that may fluctuate over an episode of care. Therefore, it is possible that low-grade inflammation may be intermittent and may occur for short periods after intense tendon loading in chronic situations characterizing an acute-on-chronic condition in some cases.

It has been postulated that LET is acquired by irritation of the hypovascular zone of the common extensor tendon at its attachment on the lateral epicondyle, which leads to subsequent neovascularization[45] that has been described as "angiofibroblastic tendinosis."[99] Chronic LET is characterized by

disorganization of collagen fibers, an increase in the number of vessels and sensory nerves, disorganized (smaller) type III collagen fibers,[161] and areas of hypocellularity or fibroblast reaction.[13,162] It is important to recognize that, despite the lack of consistent evidence relating to the presence or absence of inflammatory cells locally,[88] other proinflammatory chemical agents including inflammatory cytokines, growth factors, prostaglandins, and neuropeptides have been detected in cases of chronic tendinopathy.[62] Neurochemicals are important in the regulation of local tendon vascular supply but are also believed to contribute to neurogenic inflammation. More recent evidence also points to altered nociceptive processing as a contributor to persistent pain associated with LET.[15,37] Preliminary evidence highlights the association of nervous system sensitization in patients with chronic tendinopathy.[147] It is important to appreciate the hypothesized underlying tissue pathology *in the context* of the complex processes related to the neuromodulation of pain, both peripherally and centrally.[59]

The complex underlying pathophysiologic mechanisms associated with LET may explain why it is difficult to accurately classify and subgroup individuals with LET in a single/simple classification system and may also explain why its symptoms are sometimes difficult to bring to full resolution. It is important to assess the intensity, irritability, and distribution of the individual's symptoms while considering their history and their required activity levels to properly manage the condition.[113]

SUMMARY

Most pathological changes in LET occur within the common extensor tendon origin at the lateral epicondyle, commonly within the fibers associated with the ECRB muscle. It is known that structural, cellular, and chemical alterations in the tendon can all exist with tendinopathy, but do not necessarily correspond with the severity of clinical presentation. Clinicians should recognize that histological confirmation of the underlying pathophysiology in LET for any patient is not realistic in practice settings. Therefore, the acuity, irritability, and the severity of LET symptoms at any given time should guide management of this condition. In chronic cases of LET, intense loading of the tendon with activity may result in low grades of inflammation creating an acute aggravation of a chronic condition.

Risk Factors

For this CPG, the term *risk* will be reserved specifically for risk factors for new onset of LET, whereas prognosis (discussed later) will refer to the predicted course of the condition after onset. A systematic review of 5 prospective cohort studies found a significant association between combined biomechanical exposure involving the wrist and elbow and incidence of LET (pooled odds ratio [OR] = 2.6; 95% CI: 1.9, 3.5).[47] A case-control study that included the general population with a diagnosis of LET reported a higher risk for women for handling tools >1 kg (women OR = 3.0; 95% CI: 1.6, 5.5; men OR = 2.1; 95% CI: 1.1, 3.8).[68] Shiri et al,[171] in their cross-sectional cohort study, found a significant association between LET and jobs that involve handling loads >20 kg at least 10 times/day for more than 20 years in a cohort of working population from a national registry (OR = 2.6; 95% CI: 1.3, 5.1).

After adjusting for age, lack of social support, and obesity in a cohort of more than 1000 newly employed workers without symptoms of LET, those who reported wrist bending/twisting and forearm twisting/rotating/screwing motion were at elevated risk of developing LET.[48] Hard perceived physical exertion combined with elbow flexion/extension (>2 hours/day) (men OR = 2.6; 95% CI: 1.9, 3.7) and wrist bending (>2 hours/day) (men OR = 5.6; 95% CI: 2.8, 11.3 and women OR = 2.9; 95% CI: 1.3, 6.5) was found to be significant risk factors for LET.[78] In a population-based study, significant associations between LET and repetitive movements of the hand or wrist for at least 2 hours/day for those with 9 to 19 years exposure (OR = 2.4; 95% CI: 1.2, 4.9) and for 20 or more years of exposure (OR = 2.8; 95% CI: 1.4, 5.8) were identified.[171]

Park et al,[141] in their case-control study that included 937 participants from a rural agricultural setting, found significant associations between LET and dominant-side involvement (OR = 3.21; 95% CI: 2.24, 4.60), female sex (OR = 2.47; 95% CI: 1.78, 3.43), manual labor (OR = 2.25; 95% CI: 1.48, 3.43), and ipsilateral rotator cuff tear (OR = 2.77; 95% CI: 1.96, 3.91).[141] Another study that included 1824 workers found a significant association between cardiovascular disease and LET symptoms (OR = 3.81; 95% CI: 2.11, 6.85), positive examination findings for LET (OR = 2.85; 95% CI: 1.59, 5.12), and combined symptoms and physical examination (OR = 6.20; 95% CI: 2.04, 18.82).[76]

In a case-control study[183] of 4998 patients with LET matched by age/sex from general practice settings, a multivariate analysis identified significant association between LET and

rotator cuff pathology (OR = 4.95; 95% CI: 3.64, 6.71), De Quervain's disease (OR = 2.48; 95% CI: 1.14, 5.37), carpal tunnel syndrome (OR = 1.50; 95% CI: 1.14, 1.98), oral corticosteroid therapy (OR = 1.68; 95% CI: 1.47, 1.92), and previous smoking history (OR = 1.20; 95% CI: 1.06, 1.36). In addition, diabetes mellitus, current smoking, trigger finger, rheumatoid arthritis, alcohol intake, and obesity were determined not to be associated with LET.[183] An earlier systematic review[190] of 13 studies identified associations between LET and the psychosocial risk factors of low control over work duties (OR = 2.2; 95% CI: 1.4, 3.2) and low social support (OR = 1.8; 95% CI: 1.2, 2.7).[190]

SUMMARY

Female sex, dominant-side involvement, previous smoking history, rotator cuff injuries, De Quervain's disease, carpal tunnel syndrome, and oral corticosteroid therapy use represent nonmodifiable risk factors for LET. Modifiable risk factors for LET include low job control, low social support, handling heavy tools greater than 20 kg, repetitive elbow/wrist flexion/extension for more than 2 hours a day, and repetitive forearm twisting/rotating/screwing movements. Diabetes, trigger finger, rheumatoid arthritis, alcohol intake, and obesity were not associated with the incidence of LET.

Clinical Course

Lateral elbow tendinopathy can be a source of lasting pain and disability for many individuals. The clinical course of LET depends heavily on the extent to which individuals are exposed to repetitive irritation of the involved structures. While some experience full and expedient resolution of symptoms with nonsurgical care, more than half of patients seeking general medical care continue to report symptoms after 1 year.[14] Regardless of past treatments, up to 20% of individuals report persistent pain for 3-5 years after care.[35] Exposure to various occupational or sports-specific stresses, as in tennis, may negatively impact prognosis and can result in lost work time due to injury.[198] Up to 55% of individuals with LET have been shown to have lingering pain and functional loss for more than 2 years after the onset of symptoms.[133] Therefore, LET may not always follow the typical course and time frames of the normal healing process. By the time an individual seeks medical care, the inflammatory process has often resolved, yet symptoms remain.

The age- and sex-adjusted annual incidence of LET in the general population has decreased significantly over time from 4.5/1000 people in 2000 to 2.4/1000 in 2012.[158] On the other hand, the proportion of surgically treated cases has tripled (1.1% in 2000-2002 to 3.2% from 2009 to 2011).[158] About 1 in 10 patients with persistent symptoms at 6 months were treated with surgery.[158]

The course of the tendinopathy is important to consider as a descriptive element as this can range from a single isolated initial episode to a re-occurrence, to an episodic condition, or it may be persistent. In persistent chronic LET, exacerbations are typically associated with an activity that in some cases may be predicted based on the amount and nature of the activity. Determining level of irritability by using pain level, distribution of pain, and level of disability can be useful in directing treatment.

SUMMARY

Although many believe the condition to be benign, LET can be debilitating for some individuals, resulting in an inability to fully perform their job, household tasks, or athletic interests. Nonsurgical interventions are the mainstay of LET management. While some individuals can fully and quickly recover, many experience persistent pain or recurrence of symptoms, contributing to a poor prognosis regarding prolonged discomfort. Protection from repetitive irritation may help minimize or eliminate exacerbations or recurrence of symptoms.

Prognosis

Prognosis refers to the predicted course of LET after its onset. Some factors may assist the clinician in predicting short-term physical therapy treatment outcome, as well as the eventual long-term outcome of LET management.

Analysis of data from a randomized control trial (RCT) with 62 subjects (mean age = 48.2 years) undergoing physical therapy that consisted of 5 treatment sessions of mobilization with movement (MWM) and exercise, found several factors at baseline associated with improved outcomes.[195] Age <49 years, pain-free grip strength (PFGS) >112 N on the affected side, and PFGS <336 N on the unaffected side predicted a self-report of symptoms being improved at 3 weeks ($P<.01$, Nagelkerke's $R^2 = 0.45$). The probability of improvement was 87%, 93%, and 100% if one, two, or three of the indicators were present, respectively.[195]

The authors of a multicenter prospective trial with 83 subjects (mean age = 44.2 years; 47 women, 36 men) undergoing physical therapy, consisting of 10 visits over 8 weeks with ultrasound (US), soft tissue massage, stretching, and strengthening components, determined predictors of 8-week outcomes.[201] Predictors for greater disability ($r^2 = 0.61$, $P = .0001$) included higher baseline Disabilities of the Arm, Shoulder and Hand (DASH) scores ($\beta = .50$; 95% CI: 0.34, 0.66), sex (female) ($\beta = 8.92$; 95% CI: 3.3, 14.5), and self-reported nerve symptoms ($\beta = 7.32$; 95% CI: 0.8, 13.8). Predictors for higher pain visual analog scale (VAS) scores ($r^2 = 0.31$, $P = .0003$) included baseline pain VAS ($\beta = .19$; 95% CI: 0.01, 0.37), sex (female) ($\beta = 9.26$; 95% CI: 0.4, 18.2), and self-reported nerve symptoms ($\beta = 15.08$; 95% CI: 4.7, 25.5). Age, duration of symptoms, elbow joint signs, cervical joint signs, and jobs with repetition did not contribute to the prognostic models ($P>.05$).[201] Follow-up on these subjects at 6 months found performing a repetitive job to be the best predictor for higher DASH ($r^2 = 0.52$, $P = .0001$) and pain VAS ($r^2 = 0.14$, $P = .0151$) scores.[200] Similar findings related to type of occupation were noted by Paoloni et al[140] and Lewis et al,[107] as those performing manual labor jobs were less likely to improve by 6 months.

Prognostic factors were examined in 131 subjects (mean age = 44 years; 80 females, 51 males) who were followed after initiation of conservative treatment that consisted of self-stretching and use of a counterforce brace.[153] Increased patient-reported disability on the DASH at 6 months was associated with initial lower pain thresholds to pressure ($\beta = -1.28$; 95% CI: −1.79, −0.78), initial higher (increased) pain sensitivity (Pain Sensitivity Questionnaire) scores ($\beta = 1.69$; 95% CI: 0.92, 2.49), and involvement in a manual labor job ($\beta = 1.12$; 95% CI: 0.84, 1.41). These 3 factors accounted for 36% of the variance in 6-month DASH scores.[153]

Analysis from an RCT of 266 subjects (163 were >40 years of age; 144 females, 122 males) found that the primary factor associated with pain reduction less than 50% at 1-year follow-up was LET on the dominant side (OR = 3.1; 95% CI: 1.4, 6.8). Age, being greater or less than 40 years of age, and sex were not significant prognostic factors.[67] Similarly, Holmedal et al[81] also found when looking at 177 subjects (mean age = 47 years; 71 women, 106 men) in an RCT, age, sex, and duration of symptoms not to be significant ($P>.05$) in predicting treatment success, as defined by a report of being much better or completely recovered, at 26- or 52-week follow-up.

A prospective international study followed 349 subjects (mean age = 48 years, 171 females, 178 males) from 2 RCTs investigating conservative interventions for LET in a primary care setting. These authors noted a combination of 20 prognostic variables, including the covariates country and treatment, contributed to only 12% of the variance in predicting pain intensity at 12-month follow-up.[205]

SUMMARY

When looking at the effect of physical therapy interventions in short term follow-up, grip strength and age were found to be useful in predicting 3-week outcomes, whereas baseline disability, female sex, and self-reported nerve symptoms may be useful in predicting 8-week outcomes. For 6-month follow-up, occupation may be important to consider as repetitive and manual labor jobs may help in predicting those with a potential for poorer outcomes. When looking at all individuals independent of treatment, the involvement of the dominant arm may be useful in predicting outcomes at 1 year. However, predicting long-term outcomes may generally be challenging, as prognostic variables do not seem to accurately predict outcomes.

Diagnosis/Classification

OVERVIEW

An accurate diagnosis of LET is very important to provide adequate and appropriate treatment. Diagnosis and classification of LET is based on adequate history taking, physical findings, and special tests (**TABLES 5-7**). An accurate diagnosis with a better understanding of the classification of LET may aid in planning a return to work and activity and may help prevent future reinjuries.

CLASSIFICATION

Classification systems are typically designed as descriptive tools, although ideally, they would be useful in directing appropriate treatment or predicting outcomes. However, limited research exists to support the use of reported classification systems related to tendinopathy in general and LET in specific. Most classification systems proposed are based on the acuity, severity, and irritability of LET individually as stand-alone classifications or a combination of these dimensions.[20,135,162,203]

Making the classification of LET even more challenging, individuals with different occupational or athletic demands and those with multiple recurrences tend to vary in their response to interventions. MacDermid and Silbernagel[113] proposed a descriptive classification (**TABLE 8**) that considers 6 classification axes, including irritability and distribution of symptoms while including descriptive information on the context (general population, sports, worker's compensation, etc), the acuity, the likely underlying pathology (usually determined by imaging), and the course (recurrent vs isolated episode or persistent symptoms). This, when used appropriately, would provide the clinician with a holistic picture of patients with LET and can be effective in tracking progress and guiding treatment. For example, when determining the stage of irritability, self-reported pain scores (NRPS) help quantify pain intensity as either mild intensity (≤3/10), moderate intensity (4-6/10), or severe intensity ≥7/10). Distribution of symptoms can be classified as unilateral and localized to the lateral epicondyle (type 1), bilateral and localized to the lateral epicondyles (type 2), or diffuse symptoms at the elbow along with cervical or diffuse UE pain or neuropathic pain (type 3).

An assessment of how symptom irritability affects function using PTREE scores can indicate mild disability (score of

TABLE 5 Resisted Middle Finger Extension Test (Maudsley's Test)[117]

ICF Category	Measurement of Impairment of Body Function
Description	Special test to assist with the diagnosis of LET
Measurement method	**Patient position:** The patient can be in sitting or standing with the elbow in full extension, forearm pronation, and fingers in extension. **Test:** The examiner supports the distal end of the forearm and applies resistance to the dorsum of the distal phalanx of the third digit of the hand, indirectly stressing the ECRB muscle and tendon. **Positive test:** Reproduction of pain at the lateral epicondyle of the humerus or within 2 cm distal to the common extensor tendon insertion site.
Nature of variable	Nominal/dichotomous
Units of measurement	None
Measurement properties	Maudsley's test showed little association with pressure pain threshold (β = .293).[145] Sensitivity = 88%[159] Sensitivity = 66%; 95% CI: 53%, 76%[51]

Abbreviations: ECRB, extensor carpi radialis brevis; ICF, International Classification of Functioning, Disability and Health; LET, lateral elbow tendinopathy.

TABLE 6 Resisted Wrist Extension Test or Cozen's Test or LET Test[117]

ICF Category	Measurement of Impairment of Body Function
Description	Special test to assist with the diagnosis of LET
Measurement method	**Patient position:** The patient can be in sitting or standing with the elbow fully extended, forearm pronated, and the wrist extended to 30°. **Test:** The patient's elbow is stabilized by the examiner's thumb, which rests on the patient's lateral epicondyle. The examiner then provides pressure to the dorsum of the second and third metacarpals using the other hand to resist active wrist extension. **Positive test:** Reproduction of pain at the lateral epicondyle of the humerus or within 2 cm distal to the common extensor tendon insertion site.
Nature of variable	Nominal/dichotomous
Units of measurement	None
Measurement properties	Cozen's test showed fair association with pressure pain threshold (β = .436).[145] Sensitivity = 84%[159] Sensitivity = 91%; 95% CI: 81%, 96%[51]

Abbreviations: ICF, International Classification of Functioning, Disability and Health; LET, lateral elbow tendinopathy.

TABLE 7 Mill's Stretch Test or Long Extensor Stretch[124]

ICF Category	Measurement of impairment of body function
Description	Special test to assist with the diagnosis of LET
Measurement method	**Patient position:** The patient can be in sitting or standing beginning with the elbow flexed to 90°, with the forearm pronated, and the wrist fully flexed. **Test:** The examiner extends the elbow slowly while palpating the lateral epicondyle. **Positive test:** Reproduction of pain at the lateral epicondyle of the humerus or within 2 cm distal to the common extensor tendon insertion site.
Nature of variable	Nominal/dichotomous
Units of measurement	None
Measurement properties	Mill's test showed little association with pressure pain threshold (β = .267).[145] Sensitivity = 53%; Specificity = 100%[159] Sensitivity = 76%; 95% CI: 63%, 85%[51]

Abbreviations: ICF, International Classification of Functioning, Disability and Health; LET, lateral elbow tendinopathy.

<20/50), moderate disability (score between 21 and 34/50), or severe disability (score >30). The presentation of symptoms can fluctuate widely depending on the individual's occupational or athletic demands during treatment.

As systems for subclassifying LET evolve and become validated, it may be possible to direct treatment to more effectively manage symptoms in specific subpopulations of individuals with LET. Physical therapists may document the classification of LET considering context, acuity, pathology, course, distribution of symptoms, and irritability, and consider these factors in treatment planning. Empirical validation of classification systems is needed to better guide treatment and future research initiatives.

SUMMARY

An accurate clinical diagnosis of LET is very important to plan treatment and to prevent recurrence. The ICD diagnosis of LET and the associated ICF diagnosis of pain and muscle function impairments are typically made when, on clinical examination, the patient presents with reports of pain local to the lateral epicondyle reproduced with palpation, resisted wrist and/or digit extension, and stretch/elongation of the long wrist extensors. There are 3 common special tests (Maudsley's, Cozen's, and Mill's stretch) that are used to arrive at a clinical diagnosis of LET. These tests have weak evidence supporting their diagnostic usefulness.[188,211] More problematic in the clinical diagnosis of LET is that several other pathologies result in a similar distribution of pain; therefore, a thorough physical examination based on the exclusion of other disorders as the cause of lateral elbow pain is especially important for a more confident diagnosis of LET. The classification system that is presented here can be utilized. However, research is required to validate classification systems and to assess their effectiveness on outcomes. Scientific inquiry into the value of subclassifying individuals into groups to allow for intervention-matching is needed.

The CPG team feels that the classification of patients with LET based on level of irritability can be useful to direct treatment. Self-reported pain, distribution of symptoms, and level of disability should all be considered in the stage of irritability. For those who have severe pain, type 3 distribution, and high disability, the focus of treatment can be on symptom modulation. Joint and soft-tissue mobility is the focus of treatment for those with moderate pain, type 3 distribution, and moderate disability. When mild pain with type 1-2 distribution and low disability is achieved, loading the wrist extensors can be done while return to function can be the focus of treatment for those with mild-absent pain, type 1-2 distribution, and mild-absent disability. It should be noted that shifting between categories is fluid and patients may often fit more than one category at a given time.

DIFFERENTIAL DIAGNOSIS

Physical therapists should be able to identify other musculoskeletal and nonmusculoskeletal conditions that mimic the clinical presentation of LET and promptly refer patients to other health care professionals for further evaluation and management, if appropriate. The steps in developing a differential diagnosis include history taking, physical examination (including proper examination of special tests), and possibly, imaging. The conditions to consider with a differential diagnosis of lateral elbow pain, although not all-inclusive, include the following:

- Cervical radiculopathy[103]
- Radial tunnel syndrome[54,154]
- Posterior interosseous syndrome[69]
- Plica syndrome[156,176]
- Radio-capitellar chondromalacia,[104]
- Posterolateral rotatory instability[90]
- Myofascial trigger points in the wrist extensors[71]

History and physical exam findings are considered the gold standard used to confirm the diagnosis. Imaging, however, can be useful in evaluating the extent of disease, identifying associated pathology, and excluding other sources of elbow pain; particularly in cases where initial nonsurgical treatment is unsuccessful. For refractory cases of LET, initial imaging should include radiographs. Radiographs are usually negative but may demonstrate calcium deposition adjacent to the lateral epicondyle and can be used to exclude other

TABLE 8 Descriptive Classification of Lateral Elbow Tendinopathy[a]

Axis I Context	Axis II Acuity	Axis IV Course
☐ General Population (screening/prevention)	☐ Acute (0-6 wk)	☐ Isolated episode
☐ Mixed Clinical Setting (Treatment)	☐ Subacute (<3 mo)	☐ Recurrent
☐ Special Population	☐ Chronic (>3 mo)	☐ Persistent
☐ Athlete _____	**Axis III**	☐ predictable
☐ Work _____	**Pathology**	☐ unpredictable
☐ Claim (Workers' Compensation)	☐ Tendinosis	
☐ Other _____	☐ Paratenonitis	
	☐ Mixed	

Axis V Distribution	Axis VI^ Irritability	
☐ Type 1: Unilateral signs/symptoms localized to lateral elbow	☐ Level 1: Mild pain* occurring after exercise/work, lasts <6 hours	Mild
☐ Type 2: Bilateral signs/symptoms that are localized to lateral elbows	☐ Level II: Mild pain* occurring after exercise/work that lasts 7-48 hours	
☐ Type 3 : Elbow + Cervical: Lateral elbow symptoms/signs combined with cervical signs/symptoms or neuropathic pain	☐ Level III: Mild pain* occurring during exercise/work that persists after activity, but does not limit activity	
	☐ Level IV: Mild* to moderate** pain that occurs during exercise/work activity, persists >6 hours and limits activity	Moderate
	☐ Level V: Moderate** overall pain ratings; severe pain with heavy activities of daily living	
	☐ Level VI: Moderate** to severe*** overall pain ratings; severe pain with light activity; intermittent pain at rest	Severe
	☐ Level VII: Constant pain at rest, severe*** pain with activity, pain disturbs sleep	

VAS Pain Score _____ PRTEE Pain Score _____ PRTEE Total score _____
^The highest stage the person is most aligned with preferably defined by validated pain and disability measures
**Mild pain: ≤3/10 on VAS; 20/50 on PRTEE pain scale and 40/100 on PRTEE full scale*
***Moderate Pain: 4-6/10 VAS; 21-34/50 on PRTEE pain scale and 41-69/100 on PRTEE full scale*
****Severe Pain: >7/10 VAS; >36/50 on PRTEE pain scale and >70/100 on PRTEE full scale*
[a]*Table adapted with permission from Joy MacDermid.*

pathologies. The advanced imaging modality most widely used is magnetic resonance imaging (MRI), followed by US.[71]

The sensitivity of MRI in detecting LET is reported to range between 90% and 100% and specificity from 83% to 100%.[123] Classic MRI findings include increased signal within or around the common extensor tendon, a discrete collection of fluid between the common extensor tendon and radial collateral ligament, and tendon thickening.[149] A meta-analysis demonstrated that MRI signal change occurred in 90% of elbows with a clinical diagnosis of LET compared to only 14% of controls.[142] Magnetic resonance imaging is often used to grade the severity of disease (mild, moderate, and severe).[26] While some authors report no statistically significant association between imaging measures and symptoms,[31,199] Qi et al[149] reported a positive correlation between the grade of tendinopathy and patient-reported pain and disability. When combined with an appropriate clinical assessment, MRI can be useful in establishing a plan of care for individuals with LET.[87]

Ultrasound can also be used to evaluate LET.[71] Findings include tendon thickening and tendon heterogeneity, tendon tears (hypoechoic regions), and tendon discontinuity.[31] Surrounding fluid and calcification can also be detected. A systematic review[52] examining the diagnostic accuracy of US in LET found that hypoechogenicity of the common extensor origin was both moderately sensitive (0.64; 95% CI: 0.56, 0.72) and highly specific (0.82; 95% CI: 0.72, 0.90) in determining which elbows had LET. Ultrasound features of chronic LET that showed high specificity included neovascularity (specificity, 1.00; 95% CI: 0.97, 1.00), calcifications (0.97; 95% CI: 0.94, 0.99), and cortical irregularities (0.96; 95%

CI: 0.88, 0.99).[52] Although US represents a less costly imaging option than MRI, its diagnostic accuracy is ultimately dependent on numerus variables such as operator experience, equipment, and stage of pathology.[71] Nonimaging techniques using electrodiagnostic studies, including electromyography and nerve conduction studies, may also be used to rule out compressive neuropathy involving the radial nerve as a cause of lateral elbow pain.

Examination

OUTCOME, ACTIVITY LIMITATIONS, SELF-REPORT MEASURES

Overview

Several outcome measures have been developed to assess patients with LET. The PROMs that are most widely used are the Patient Rated Tennis Elbow Evaluation (PRTEE), the DASH questionnaire, the numeric pain-rating scale (NPRS), and the Patient-Specific Functional Scale (PSFS) (**TABLES 9-12**). The commonly used clinician-based outcome measures are the Mayo Elbow Performance Index (MEPI) and Roles and Maudsley score (RM Score) (**TABLES 13-14**).

ACTIVITY LIMITATIONS PHYSICAL PERFORMANCE MEASURES

Activity limitation measures have not been reported in the literature, other than what is indicated for the patient self-report questionnaires. The objective quantification of the following activities can help the clinician to assess changes in the patient's level of function over time: hand and arm use; turning or twisting the hands or arms; lifting and carrying objects; fine motor use of hand; throwing, bat, and racket activity in sport.

Clinicians can utilize easily reproducible activity limitation and participation restriction measures associated with their patients' elbow pain to assess the changes in the patient's level of UE function over the episode of care.

Evidence Synthesis

Based on the results from high-quality clinical measurement studies, the PRTEE, DASH, PSFS, and VAS all have demonstrated excellent test-retest reliability, moderate to high levels of construct validity, high levels of sensitivity to change, and responsiveness in several populations. However, except for the PRTEE, all the other self-report measures lack validation in an LET population. Because the PSFS assesses restriction of functional activities important to each individual, rigorous activities that are not assessed in other self-report measures (eg, work, hobbies, or athletic endeavors) can be monitored objectively over time. Optional work and sports/performing arts modules of the DASH may also provide valid, reliable, and responsive measures of important functional tasks involving the UE. The clinician-based outcome measures (MEPI and RM Score) have demonstrated acceptable levels of clinical measurement properties; however, there is a paucity of evidence in terms of the number of studies. Neither the RM Score or the MEPI have been validated extensively in a population of individuals with LET. Validated outcome measure(s) should be administered at baseline and discharge with other follow-up points being obtained as needed to assess change for all patients with LET.

Gaps in Knowledge

More high-quality studies are required to evaluate the clinical measurement properties, especially construct validity and responsiveness, including MCID of the DASH, PSFS, and VAS in the LET population. The clinical measurement properties of the RM Score and MEPI need to be evaluated in the LET population to further support their use and effectiveness in an LET population. Studies are also needed to support the interpretation of objective and reproducible measures of activity limitation and performance measures.

RECOMMENDATION

A Clinicians should use the diagnosis-specific PRTEE to assess pain/irritability and function and/or the region-specific DASH to assess UE function at baseline and at least one other follow-up point, which includes discharge, for individuals with LET.

A Clinicians should use the PSFS for patients with high-demand activities and/or should administer a scale that assesses activity-specific disability (eg, DASH work or sports/performing arts module) at baseline and at least one other follow-up point, which includes discharge, for individuals with LET.

PATIENT-REPORTED OUTCOME MEASURES

TABLE 9 Patient-Rated Tennis Elbow Evaluation Questionnaire (PRTEE)

ICF Category	Activity Limitations and Participation Restrictions	
Description	The PRTEE[112] is a 15-item self-reported questionnaire to measure patients' perceived pain and disability. It has 5 items on pain, 6 items on the difficulty in performing usual activities, and 4 items on the difficulty in performing specific activities. Each of the items is scored on a 0-10 scale. The total score ranges from 0 to 100 where 100 indicates greater disability. It takes approximately 5 minutes to complete.[138]	
Clinical measurement properties	**Test-retest reliability:**	Intraclass correlation coefficient (ICC) = 0.96[131]
	Work-related LET	ICC (2,1) = 0.89[138]
	Mixed group-work and nonwork-related LET	r^2 = 0.87[157]
	LET in tennis players	ICC = 0.76[32]
	LET in the general population	
	Internal consistency:	0.85-0.94 across the subscales[155] 0.96[119]
	Standard error of measurement (SEM)	0.6[138]
	Construct validity:	r = 0.72 to 0.88[4,119,131,155,166]
	With DASH	r = 0.89[4]
	With Patient Rated Wrist Evaluation (PRWE)	r = 0.61[4]
	With Hospital Anxiety & Depression Scale (HADS) (depression subscale)	r = −0.45[131] r = 0.66[131]
	With Pain-Free Grip Strength (PFGS)	r = −0.61[131]
	With VAS for pain	r = −0.65[131]
	With Short Form-36 (Physical function)	
	With Short Form-36 (bodily pain)	
	Sensitivity to change:	Standardized response mean (SRM) = 0.84 : effect size (ES) = 1.06[32] SRM =1.9 : ES = 1.6[131] SRM = 2.0[155]
	Minimal clinically important difference (MCID)	Seven points for participants who rated themselves as "a little better" and 11 points for participants who rated themselves as "much better" or "completely recovered" on the global change scale (GCS).[148]
	Translation and cross-cultural adaptations:	Greek[175]
	All versions were comparable to the original English version and have demonstrated acceptable psychometric properties.	Canadian French[18] Turkish[5] Dutch[189] French[93] Italian[24] Swedish[132] Hong Kong Chinese[106] Persian[119] Korean[97] German[120] Persian[86] Persian[166]
Instrument variations	The PRTEE was initially called the Patient Rated Forearm Evaluation Questionnaire (PRFEQ).[112,138]	

Abbreviations: ICF, International Classification of Functioning, Disability and Health; LET, lateral elbow tendinopathy; PRTEE, Patient-Rated Tennis Elbow Evaluation.

TABLE 10 Disabilities of the Arm, Shoulder and Hand Questionnaire (DASH)

ICF Category	Activity Limitations and Participation Restrictions	
Description	The DASH is a region-specific self-report questionnaire to measure impairments and functional limitations due to disorders in the upper limb. There is an optional component containing questions covering sports and performing arts, and work. The total DASH score ranges from 0 (no disability) to 100 (severe disability). The DASH has been extensively used in efficacy studies on the management of LET.[11]	
Clinical measurement properties	**Test-retest reliability:**	ICC = 0.91-0.96 (UE musculoskeletal disorders)[11,160]
	SEM	SEM = 4.6-5.22 (UE musculoskeletal disorders)[11,160]
	Construct validity:	*r* = 0.72-0.88[4,119,131,155,166]
	With PRTEE	r = 0.67-0.71[160]
	With Global Disability Rating	
	Sensitivity to change:	SRM = 1.6 (tennis players)[155] SRM = 0.9 (general population)[131] Minimal detectable change (MDC_{90}) = 12.2 (UE musculoskeletal disorders)[160] MDC_{90} = 10.7 (UE musculoskeletal disorders)[11]
	MCID	MCID = 10.2 (UE musculoskeletal disorders)[160]
Instrument variations	The DASH has a shorter version called the QuickDASH, which has 11 items from the DASH.[11] No studies are available on the psychometric properties of the QuickDASH in an LET sample.	

Abbreviations: ICC, intraclass correlation coefficient; ICF, International Classification of Functioning, Disability and Health; LET, lateral elbow tendinopathy; MCID, minimal clinically important difference; MDC, minimal detectable change; SEM, standard error of measurement; SRM, standardized response mean; UE, upper extremity; PRTEE, Patient-Rated Tennis Elbow Evaluation.

TABLE 11 Patient-Specific Functional Scale (PSFS)

ICF Category	Activity Limitations and Participation Restrictions	
Description	The PSFS is a self-report outcome measure that is used to quantify patient-identified activity limitations related to any musculoskeletal disorder. Patients self-select activities to rate on an 11-point scale. The anchor "0" represents being "unable to perform" the task, and "10" represents being "able to perform at prior level." Measurement properties have been established for adults with general UE musculoskeletal conditions[75] but have not been specifically tested for adults with LET.	
Clinical measurement properties	Test-retest reliability:	ICC = 0.97 (chronic pain)[177]
	Interrater reliability:	ICC (2,1) = 0.71 (UE musculoskeletal disorders)[75]
	SEM:	SEM = 0.41 (chronic pain)[177]
	Criterion Validity (Concurrent Validity)	*r* = −0.67 (chronic pain)[177] with Roland-Morris
	Minimal DetecTABLE Change (MDC)	MDC = 2 points (chronic pain)[177]
	MCID	MCID = 1.2 points (UE musculoskeletal disorders)[75]

Abbreviations: ICC, intraclass correlation coefficient; ICF, International Classification of Functioning, Disability and Health; LET, lateral elbow tendinopathy; MCID: minimal clinically important difference; MDC, minimal detectable change; SEM, standard error of measurement; UE, upper extremity.

TABLE 12 The Numeric Pain-Rating Scale (NPRS)

ICF Category	Self-report of Impairment of Body Function: Pain Levels	
Description	To measure or evaluate the levels of pain, clinicians use a variety of self-report tools in their practice such as VAS, NPRS, and verbal rating scale. A systematic review[80] conducted to compare different scales used to measure pain intensity in adults concluded NPRS to be the ideal measure. Patients rate their level of pain on a scale of 0-10 ("0" = no pain and "10" = worst imaginable pain).[61,80] It has been shown to have acceptable psychometric properties. In a study looking into the validity of 4 pain rating scales, the NPRS was reported to be more responsive and sensitive to change than other scales.[61]	
Clinical measurement properties	**Test-retest reliability:**	ICC (2,1) = 0.74 (95% CI: 0.55, 0.86) (UE musculoskeletal disorders, including elbow disorders)[75]
	Construct validity: **PRTEE** **PSFS**	*r* = 0.84 (patients with LET)[155] *r* = 0.51 (95% CI: 0.39, 0.61) (UE musculoskeletal disorders, including elbow disorders)[75]
	MDC	5.7 (95% CI: 3.8, 7.2) (UE musculoskeletal disorders, including elbow disorders)[75] Note: calculated for a sum of 3 administrations scores range from 0 to 30
	MCID	1 point (chronic musculoskeletal pain)[157] 2 points (chronic pain)[57]

Abbreviations: ICC, intraclass correlation coefficient; ICF, International Classification of Functioning, Disability and Health; LET, lateral elbow tendinopathy; MCID: minimal clinically important difference; MDC, minimal detectable change; PRTEE, Patient-Rated Tennis Elbow Evaluation; PSFS, Patient-Specific Functional Scale; UE, upper extremity; VAS, visual analog scale.

CLINICIAN-BASED OUTCOME MEASURES

TABLE 13 Roles and Maudsley (RM) Score

ICF Category	Activity Limitations and Participation Restrictions	
Description	The RM Score was first described by Roles and Maudsley to classify the outcome after surgery for persistent LET cases.[154] Since then, it has been used in classifying outcomes in nonsurgical management. This score is provided by the clinician based on their observations and outcomes and is classified into 4 levels: Excellent – no pain, full movement, full activity; Good – occasional discomfort, full movement, full activity; Fair – some discomfort after prolonged activity; Poor – pain limiting activities.[154] However, the RM score has not been validated extensively in the LET population.	
Clinical measurement properties	**Construct validity:** With PRTEE (Swedish version)	*r* = 0.78[132]
	Sensitivity to change:	SRM of 1.52 (tennis players)[155]

Abbreviations: ICF, International Classification of Functioning, Disability and Health; LET, lateral elbow tendinopathy; PRTEE, Patient-Rated Tennis Elbow Evaluation; SRM, standardized response mean; UE, upper extremity; VAS, visual analog scale.

TABLE 14 Mayo Elbow Performance Index (MEPI)

ICF Category	Activity Limitations and Participation Restrictions	
Description	The MEPI is another clinician-based outcome measure that has been used in studies looking into the efficacy of treatment for LET. This index comprises 4 parts: pain (45 points), elbow range of motion (ROM) (20 points), stability (10 points), and the ability to do functional tasks (25 points). The maximum total score possible is 100. A higher score indicates better function. The interpretation for the MEPI scores is: 90 to 100 points – excellent; 75 to 89 points – good; 60 to 74 points – fair; less than 60 points – poor. In general, the MEPI has demonstrated acceptable levels of clinical measurement properties.[126] However, the MEPI has not been validated extensively in the LET population.	
Clinical measurement properties	**Construct validity**	r = 0.83 to 0.89[186]
	with other similar scoring systems of the elbow	r = –0.56[186]
	With DASH	r = 0.64[186]
	With M-ASES-e	
Instrument variations	There are at least 3 variants of the MEPI, each focusing on various aspects of the actual MEPI in different proportions.[192]	

Abbreviations: DASH, Disabilities of the Arm, Shoulder and Hand; ICF, International Classification of Functioning, Disability and Health; LET, lateral elbow tendinopathy; M-ASES-e, Modified American Shoulder and Elbow Surgeons patient self-evaluation form.

PHYSICAL IMPAIRMENT MEASURES

Overview

Activities that involve overloading of the wrist and digit extensor muscles are associated with LET and may result in impairments including pain with motion of the elbow, forearm, wrist, and hand, and with resisted activity such as gripping. Range of motion (ROM) loss could also point to another pathology related to joint dysfunction and, therefore, may be useful in determining a differential diagnosis. Commonly used impairment measures are the elbow, forearm, and wrist ROM (**TABLES 15-18**), pressure pain threshold (**TABLE 19**), PFGS (**TABLE 20**), and maximal grip strength (**TABLE 21**). Measurement of wrist extension strength may be performed but little research supports its use as an outcome measure. Rather, pain with resisted wrist extension is assessed through special tests. Measurement of grip strength may serve as an indicator of function and strength of the wrist stabilizers.

TABLE 15 Elbow Range of Motion

ICF Category	Measurement of Impairment of Body Function: Mobility of Joints
Description	The amount of active elbow flexion/extension ROM is measured using a universal goniometer. Flexion/extension of the elbow can be measured from the lateral side. The forearm is in supination, and the hand is held with the palm upward. The goniometer arms are positioned parallel to the midline of the arm and forearm. The value "0" is described as full neutral extension/flexion. Hyperextension is indicated by positive values, whereas a loss in extension is indicated by negative values.
Measurement properties	***Intrarater reliability:***
	Flexion ICC = 0.95 (UE musculoskeletal disorders)[6]; 0.76 (95% CI: 0.47, 0.90) SEM 3° (Normal subjects)[212]
	Extension ICC = 0.92 (UE musculoskeletal disorders)[6]; 0.92 (95% CI: 0.80, 0.97) SEM 2°(Normal subjects)[212]
	Interrater reliability:
	Flexion ICC = 0.58-0.62(UE musculoskeletal disorders)[6]; 0.86 (95% CI: 0.53, 0.96) SEM 2°(Normal subjects)[212]
	Extension ICC = 0.58-0.87 (UE musculoskeletal disorders)[6]; 0.89 (95% CI: 0.63, 0.97) SEM 1° (Normal subjects)[212]
	The precision of measurement (Standard deviation of random error): (LET)[174]
	Flexion = 2°
	Extension = 2°
	Concurrent validity:
	With fluid-based goniometer r = 0.83 (Normal subjects)[143]
	MDC_{95}:
	Flexion 10°(UE musculoskeletal disorders)[6]
	Extension 10°(UE musculoskeletal disorders) [6]
Instrument variations	Fluid goniometer,[143] JTECH goniometer,[9] and NK goniometer[6]

Abbreviations: ICC, intraclass correlation coefficient; ICF, International Classification of Functioning, Disability and Health; LET, lateral elbow tendinopathy; MDC, minimal detectable change; ROM, range of motion; SEM, standard error of measurement; UE, upper extremity.

TABLE 16 Forearm Range of Motion

ICF Category	Measurement of Impairment of Body Function: Mobility of Joints
Description	The amount of active forearm supination/pronation ROM is measured using a universal goniometer. The elbow is flexed to 90° and kept by the side of the trunk adjacent to the body and with the forearm unsupported in a neutral position (thumb up). To measure pronation, the stable arm of the goniometer is placed parallel to the humerus, and the movable arm is in contact with the dorsal aspect of the wrist near the ulnar styloid process; the patient is asked to actively rotate the forearm inward (palm down) as far as possible. To measure supination, the stable arm of the goniometer is placed parallel to the humerus and the moveable arm is in contact with the volar aspect of the wrist near the ulnar styloid process; the patient is asked to actively rotate the forearm outward (palm up) as far as possible.
Measurement properties	***Intratester reliability:*** **Pronation** ICC (3,1) = 0.86 to 0.98 (SEM 1.4° to 2.8°) (UE musculoskeletal disorders and normal subjects)[91] ICC (2,1) = 0.89 (95% CI: 0.80, 0.94) (SEM 2.10°) NK goniometer (UE musculoskeletal disorders)[9] ICC (2,1)= 0.86 (95% CI: 0.77, 0.92) (SEM 2.24°) JTECH goniometer (UE musculoskeletal disorders)[9] ICC = 0.90 (95% CI: 0.77, 0.96) SEM 8° (Normal subjects)[212] **MDC_{90}:** 4.90° (NK Goniometer); 5.23° (JTECH goniometer) (UE musculoskeletal disorders)[9] **MDC_{95}:** 5.82° (NK Goniometer); 6.21° (JTECH goniometer) (UE musculoskeletal disorders)[9] **Supination** ICC (3,1) = 0.96 to 0.98 (SEM 1.9° to 2.2°) (UE musculoskeletal disorders and normal subjects)[91] ICC (2,1)= 0.94 (95% CI: 0.85, 0.96) (SEM 3.20°) NK goniometer (UE musculoskeletal disorders)[9] ICC (2,1) = 0.95 (95% CI: 0.90, 0.97) (SEM 1.95°) JTECH goniometer (UE musculoskeletal disorders)[9] ICC = 0.91 (95% CI: 0.78, 0.96) SEM 8° (Normal subjects)[212] **MDC_{90}:** 5.13° (NK Goniometer); 4.55° (JTECH goniometer) (UE musculoskeletal disorders)[9] **MDC_{95}:** 6.10° (NK Goniometer); 5.40° (JTECH goniometer) (UE musculoskeletal disorders)[9] ***Interrater reliability:*** **Pronation** ICC (2,3) = 0.92 to 0.95 (SEM 2.4°) (UE musculoskeletal disorders and normal subjects)[91] ICC (2,1) = 0.76 to 0.93 (UE musculoskeletal disorders and normal subjects)[33] ICC (2,1) = 0.83 (95% CI: 0.71, 0.90) (SEM 3.11°) NK goniometer (UE musculoskeletal disorders)[9] ICC (2,1) = 0.79 (95% CI: 0.69, 0.89) (SEM 3.02°) JTECH goniometer (UE musculoskeletal disorders)[9] ICC = 0.92 (95% CI: 0.47, 0.98) SEM 3° (Normal subjects)[211] **MDC_{90}:** 7.26° (NK goniometer); 7.05° (JTECH goniometer) (UE musculoskeletal disorders)[9] **MDC_{95}:** 8.62° (NK goniometer); 8.37° (JTECH goniometer) (UE musculoskeletal disorders)[9] **Supination** ICC (2, 3) = 0.94 to 0.96 (SEM 2.9° to 3.9°) (UE musculoskeletal disorders and normal subjects)[91] ICC (2, 1) = 0.92 to 0.97 (UE musculoskeletal disorders and normal subjects)[33] ICC (2, 1) = 0.87 (95% CI: 0.73, 0.93) (SEM 3.78°) NK goniometer (UE musculoskeletal disorders)[9] ICC (2, 1) = 0.84 (95% CI: 0.49, 0.94) (SEM 3.96°) JTECH goniometer (UE musculoskeletal disorders)[9] ICC = 0.87 (95% CI: 0.56, 0.97) SEM 3° (Normal subjects)[211] **MDC_{90}:** 8.82° (NK goniometer); 9.24° (JTECH goniometer) (UE musculoskeletal disorders)[9] **MDC_{95}:** 10.48° (NK Goniometer); 10.98° (JTECH goniometer) (UE musculoskeletal disorders)[9] Pronation 10° (UE musculoskeletal disorders)[6] Supination 11° (UE musculoskeletal disorders) [6]
Instrument variations	Fluid goniometer,[143] NK goniometer,[6] JTECH goniometer,[9] and pronation-supination goniometer[6]

Abbreviations: ICC, intraclass correlation coefficient; ICF, International Classification of Functioning, Disability and Health; MDC, minimal detectable change; SEM, standard error of measurement; UE, upper extremity.

TABLE 17 Wrist Range of Motion

ICF Category	Measurement of Impairment of Body Function: Mobility of Joints
Description	The amount of active wrist flexion/extension ROM is measured using a universal goniometer. The elbow is held flexed to approximately 90°, the forearm in pronation, and the wrist in neutral flexion/extension. The distal arm of the goniometer is placed along the lateral aspect of the fifth metacarpal, and the proximal goniometer arm is placed along the lateral aspect of the forearm triquetrum. The flexion/extension angles are measured from a lateral view.
Measurement properties	***Intratester reliability:*** **Flexion:** ICC(1,1) = 0.95 (lower limit of 95% CI: 0.93) (SEM 4.52°) (UE musculoskeletal disorders)[83] ICC (3,I) = 0.86 to 0.92 (SEM 5.74° to 7.22°) (UE musculoskeletal disorders)[102] ICC (2,1) = 0.97 (95% CI: 0.95, 0.98) (SEM 1.98°) NK goniometer (UE musculoskeletal disorders)[9] ICC (2,1) = 0.95 (95% CI: 0.91, 0.97) (SEM 2.59°) JTECH goniometer (UE musculoskeletal disorders)[9] **MDC_{90}:** 4.62° (NK goniometer); 6.04° (JTECH goniometer) (UE musculoskeletal disorders)[9] **MDC_{95}:** 5.49° (NK goniometer); 7.18° (JTECH goniometer) (UE musculoskeletal disorders)[9] **Extension** ICC (1,1) = 0.96 (lower limit of 95% CI: 0.94) (SEM 3.65°) (UE musculoskeletal disorders)[83] ICC (3,I) = 0.80 to 0.94 (SEM 5.57° to 7.82°) (UE musculoskeletal disorders)[102] ICC (2,1) = 0.95 (95% CI: 0.91, 0.97) (SEM 2.06°) NK goniometer (UE musculoskeletal disorders)[9] ICC (2,1) = 0.94 (95% CI: 0.72, 0.94) (SEM 2.47°) JTECH goniometer (UE musculoskeletal disorders)[9] **MDC_{90}:** 4.81° (NK goniometer); 5.76° (JTECH Goniometer) (UE musculoskeletal disorders)[9] **MDC_{95}:** 5.71° (NK goniometer); 6.85° (JTECH goniometer) (UE musculoskeletal disorders)[9] ***Interrater reliability:*** **Flexion** ICC (1,1) = 0.90 (lower limit of 95% CI: 0.85) (SEM 6.57°) (UE musculoskeletal disorders)[83] ICC (2,I) = 0.88 to 0.93 (SEM 5.54° to 6.56°) (UE musculoskeletal disorders)[102] ICC = 0.94 (95% CI: 0.89, 0.97) (SEM 2.12°) (Normal subjects)[42] ICC = 0.89 (95% CI: 0.80, 0.94) (SEM 3.65°) (electrogoniometer) (Normal subjects)[42] ICC (2,1) = 0.97 (95% CI: 0.95, 0.98) (SEM 3.64°) NK goniometer (UE musculoskeletal disorders)[9] ICC (2,1) = 0.87 (95% CI: 0.88, 0.97) (SEM 3.48°) JTECH goniometer (UE musculoskeletal disorders)[9] **MDC_{90}:** 8.49° (NK goniometer); 8.12°(JTECH goniometer) (UE musculoskeletal disorders)[9] **MDC_{95}:** 10.09° (NK goniometer); 11.86° (JTECH goniometer) (UE musculoskeletal disorders)[9] **Extension** ICC (1,1) = 0.85 (lower limit of 95% CI: 0.77) (SEM 7.00°) (UE musculoskeletal disorders)[83] ICC (2,I) = 0.80 to 0.84 (SEM 6.00° to 7.69°) (UE musculoskeletal disorders)[102] ICC = 0.90 (95% CI: 0.83, 0.95) (SEM 1.67°) (Normal subjects)[42] ICC = 0.91 (95% CI: 0.83, 0.95) (SEM 3.10°) (electrogoniometer) (Normal subjects)[42] ICC (2,1) = 0.95 (95% CI: 0.91, 0.97) (SEM 2.06°) NK goniometer (UE musculoskeletal disorders)[9] ICC (2,1) = 0.93 (95% CI: 0.90, 0.97) (SEM 2.82°) JTECH goniometer (UE musculoskeletal disorders)[9] **MDC_{90}:** 4.81° (NK Goniometer); 6.58° (JTECH goniometer) (UE musculoskeletal disorders)[9] **MDC_{95}:** 9.65° (NK Goniometer); 7.82° (JTECH goniometer) (UE musculoskeletal disorders)[9]
Instrument variations	Fluid goniometer,[143] JTECH goniometer,[9] and NK goniometer[6]

Abbreviations: ICC, intraclass correlation coefficient; ICF, International Classification of Functioning, Disability and Health; MDC, minimal detectable change; SEM, standard error of measurement; UE, upper extremity.

TABLE 18 Wrist Range of Motion, and Radial and Ulnar Deviation of the Wrist

ICF Category	Measurement of Impairment of Body Function: Mobility of Joints
Description	The amount of active wrist radial and ulnar deviation ROM is measured using a universal goniometer. The elbow is flexed to 90°, the forearm is pronated, the wrist is in neutral, fingers are extended and adducted, and the palm is flat on the table. One arm of the goniometer is aligned with the third metacarpal and the other is in line with the radius with the axis at the capitate bone. For radial deviation, the hand is actively deviated to the radial side as far as possible, and for ulnar deviation, the hand is actively deviated towards the ulnar side as far as possible.
Measurement properties	***Intrarater reliability:*** **Radial deviation** ICC (1,1) = 0.90 (lower limit of 95% CI: 0.86) (SEM 2.55°) (UE musculoskeletal disorders)[83] ICC (2,1) = 0.96 (95% CI: 0.92, 0.98) (SEM 0.96°) NK goniometer (UE musculoskeletal disorders)[9] ICC (2,1) = 0.93 (95% CI: 0.88, 0.96) (SEM 1.26°) JTECH goniometer (UE musculoskeletal disorders)[9] **MDC_{90}:** 2.24° (NK goniometer); 3.04° (JTECH goniometer) (UE musculoskeletal disorders)[9] **MDC_{95}:** 2.66° (NK goniometer); 3.49° (JTECH goniometer) (UE musculoskeletal disorders)[9] **Ulnar deviation** ICC (1,1) = 0.92 (lower limit of 95% CI: 0.88) (SEM 3.48°) (UE musculoskeletal disorders)[83] ICC (2,1) = 0.91 (95% CI: 0.85, 0.95) (SEM 1.98°) NK goniometer (UE musculoskeletal disorders)[9] ICC (2,1) = 0.93 (95% CI: 0.89, 0.96) (SEM 2.06°) JTECH goniometer (UE musculoskeletal disorders)[9] **MDC_{90}:** 4.62° (NK goniometer); 4.81° (JTECH goniometer) (UE musculoskeletal disorders)[9] **MDC_{95}:** 5.49° (NK goniometer); 5.71° (JTECH goniometer) (UE musculoskeletal disorders)[9] ***Interrater reliability:*** **Radial deviation** ICC (1,1) = 0.86 (lower limit of 95% CI: 0.78) (SEM 3.03°) (UE musculoskeletal disorders)[83] ICC = 0.86 (95% CI: 0.76, 0.93) (SEM 1.79°) (Normal subjects)[42] ICC = 0.90 (95% CI: 0.82, 0.95) (SEM 2.13°) (electrogoniometer) (Normal subjects)[42] ICC (2,1) = 0.84 (95% CI: 0.73, 0.91) (SEM 2.16°) NK goniometer (UE musculoskeletal disorders)[9] ICC (2,1) = 0.87 (95% CI: 0.72, 0.93) (SEM 1.94°) JTECH goniometer (UE musculoskeletal disorders)[9] **MDC_{90}:** 5.04° (NK goniometer); 4.53° (JTECH goniometer) (UE musculoskeletal disorders)[9] **MDC_{95}:** 5.99° (NK goniometer); 5.76° (JTECH goniometer) (UE musculoskeletal disorders)[9] **Ulnar deviation** ICC (1,1) = 0.78 (lower limit of 95% CI: 0.67) (SEM 5.77°) (UE musculoskeletal disorders)[83] ICC = 0.81 (95% CI: 0.66, 0.90) (SEM 2.29°) (Normal subjects)[42] ICC = 0.93 (95% CI: 0.88, 0.96) (SEM 1.93°) (electrogoniometer) (Normal subjects)[42] ICC(2,1) = 0.82 (95% CI: 0.51, 0.92) (SEM 2.60°) NK goniometer (UE musculoskeletal disorders)[9] ICC (2,1) = 0.93 (95% CI: 0.89, 0.96) (SEM 2.06°) JTECH goniometer (UE musculoskeletal disorders)[9] **MDC_{90}:** 6.07° (NK Goniometer); 4.81° (JTECH goniometer) (UE musculoskeletal disorders)[9] **MDC_{95}:** 7.17° (NK Goniometer); 5.38° (JTECH goniometer) (UE musculoskeletal disorders)[9]
Instrument variations	Fluid goniometer,[143] JTECH goniometer,[9] and NK goniometer[6]

Abbreviations: ICC, intraclass correlation coefficient; ICF, International Classification of Functioning, Disability and Health; MDC, minimal detectable change; SEM, standard error of measurement; UE, upper extremity.

TABLE 19 Pressure Pain Threshold (PPT)

ICF Category	Measurement of Impairment of Body Function: Pain Sensitivity
Description	The minimum pressure that produces pain or discomfort when the head of the algometer is applied perpendicular to the common extensor tendon at the lateral epicondyle of the humerus. The PPT is measured in kg/cm^2; the value is often reported as a force given an instrument with a set surface area.
Measurement properties	Individuals with LET: ***Interobserver 95% limits of agreement:*** *–2.82, 1.50 kg/cm*[2173] ***Interobserver reliability:*** *ICC = 0.77; 95% CI: 0.62, 0.86*[173] ***Intratester reliability:*** *ICC (3,1) = 0.95*[193] ***Between-session reliability:*** ICC (2,3) = 0.93; 95% CI: 0.85, 0.97[72] ***Within-session reliability:*** ICC (2,3) = 0.93; 95% CI: 0.85, 0.97[72] **SMD** (similar to MDC_{95}) 1.5 kg/cm[2173] **MDC:** Between-session MDC 1.79 kg/cm[272] Within-session MDC 1.64 kg/cm[275]

Abbreviations: ICC, intraclass correlation coefficient; ICF, International Classification of Functioning, Disability and Health; LET, lateral elbow tendinopathy; MDC, minimal detectable change; SMD, standardized mean difference.

Evidence Synthesis

Physical impairment measures of wrist ROM, elbow ROM, pressure pain threshold (PPT), PFGS, and maximum grip strength have all demonstrated excellent interrater and intrarater reliability in those with LET. The MDC values are available for all the described impairment measures. The PFGS was the only impairment measure that had any information on diagnostic accuracy in an LET sample. A recent international study that aimed at developing a core outcome set for lateral elbow tendinopathy (COS-LET)[10] using the best available evidence and an international consensus process, recommended the use of PFGS measurements and did not include wrist extension strength in the core outcome measures for LET. Measurement of physical impairments provide objective measures of impairment deficits, can assist in monitoring change throughout the course of care, and can provide information regarding the individual's prognosis. Potential harms include having the individual with irritable symptoms overexert the wrist extensors during assessment causing symptom aggravation.

Gaps in Knowledge

Except for the wrist and elbow ROM measures, all the other measures had a limited number of studies looking into their clinical measurement properties in the LET population. Measurement of wrist extension strength needs more research in terms of the optimal method of testing and its validity, reliability, responsiveness, and diagnostic utility in the clinical setting.

RECOMMENDATION

Physical Impairment Measures

B Clinicians should include the physical impairment measures of elbow and wrist range of motion, PPT, PFGS, and maximum grip strength at baseline and at least one other follow-up point, that includes discharge, for individuals with LET.

TABLE 20 Pain-Free Grip Strength (PFGS)

ICF Category	Measurement of Impairment of Body Function: The Strength of the Muscles
Description	The amount of force that a patient can generate before any pain is felt during a grip strength test using a handgrip dynamometer. The patient should be seated with the elbow extended, the forearm pronated, and the wrist in slight wrist extension. The handle position of the dynamometer is set consistently for the individual patient, and the mean of 3 successive trials should be used.
Measurement properties	Individuals with LET: ***Interobserver 95% limits of agreement:*** *–5.09, 6.6 kg-force*[173] Interobserver reliability: ICC = 0.97 (95% CI: 0.94, 0.98)[173] Intratester reliability ICC (3,1) = 0.89[193] ***Between-session reliability:*** **Elbow flexed** ICC (2,3) = 0.86; 95% CI: 0.69, 0.94[72] ICC (2,1) = 0.89; 95% CI: 0.75, 0.95[79] **Elbow extended** ICC (2,3) = 0.93; 95% CI: 0.84, 0.97[72] ICC (2,1) = 0.94; 95% CI: 0.85, 0.97[79] ***Within-session reliability:*** **Elbow flexed** ICC (2,3) = 0.96; 95% CI: 0.92, 0.98[72] ICC (2,1) = 0.96; 95% CI: 0.92, 0.99[79] **Elbow extended** ICC (2,3) = 0.97; 95% CI: 0.93, 0.98[72] ICC (2,1) = 0.98; 95% CI: 0.93, 0.99[79] **SMD** 1.4 kg-force[173] **MDC-Between session** Elbow flexed: 9.2 kg-force[79] Elbow extended: 9.4 kg-force[79] **MDC-Within Sessions** Elbow flexed: 5.3 kg-force[79] Elbow extended: 4.7 kg-force[79] **Validity:** With VAS *r* = 0.47[179] With PRTEE *r* = –0.36[138] **Sensitivity** 65%[180] **Specificity** 97%[180] **Clinically Important Change** 7 kg-force[180]

Abbreviations: ICC, intraclass correlation coefficient; ICF, International Classification of Functioning, Disability and Health; LET, lateral elbow tendinopathy; MDC, minimal detectable change; PRTEE, Patient-Rated Tennis Elbow Evaluation; SMD, standardized mean difference; VAS, visual analog scale.

TABLE 21 Maximum Grip Strength

ICF Category	Measurement of Impairment of Body Function: The Strength of the Muscles
Description	The maximum amount of force that a patient can generate during a grip strength test using a handgrip dynamometer. The patient should be seated with the shoulder adducted and neutrally rotated, the elbow extended, and the forearm and wrist in neutral position. The second handle position of the dynamometer and the mean of 3 successive trials should be used. Clinicians may measure maximum grip strength in both elbow flexed and extended positions.
Measurement properties	Individuals with LET: ***Interobserver 95% limits of agreement:*** *–4.73, 3.11 kg*[173] **SMD** (similar to MDC_{95}) = 0.8 kg[173]

Abbreviations: ICF, International Classification of Functioning, Disability and Health; LET, lateral elbow tendinopathy; MDC, minimal detectable change; SMD, standardized mean difference; VAS, visual analog scale.

Interventions

OVERVIEW

Multiple investigations, including randomized clinical trials (RCTs), systematic reviews, and meta-analyses, have been conducted examining the effect of various treatment approaches and interventions on LET. The goals of LET management are to minimize pain, improve strength, and restore function of the UE. Interventions range from exercise prescription, manual therapy techniques, and various electrotherapeutic modalities. Supportive devices and ergonomic interventions are also used to off-load the common extensor tendon. The following section provides an overview of the investigations examining the effect of interventions commonly used to treat individuals with LET.

EXERCISE

Exercise in Isolation

I Forty participants with LET for 6 weeks or longer were randomly allocated to either an unsupervised isometric exercise group (n = 21) or a wait-and-see group (n = 19).[196] The primary outcomes were pain (worst/rest using a NPRS), disability (PRTEE), global improvement (GROC), and PFGS. The unsupervised exercise group reported a decrease in worst pain (standardized mean difference [SMD], −0.80; 95% CI: −1.45, −0.14) and disability (SMD, −0.92; 95% CI: −1.58, −0.26), but not in perceived rating of change or PFGS when compared with wait and see at 8 weeks. No serious adverse effects were reported.[196]

II Yoon et al[208] conducted a systematic review and meta-analysis on the effects of eccentric exercises in the management of LET and included 6 trials. All studies compared eccentric exercise in isolation to other physical therapy interventions. A significant improvement in the VAS score after eccentric exercise (SMD, −0.63; 95% CI: −0.90, −0.36) relative to the comparison group was observed in the 4 studies that looked at VAS. Four studies reported outcomes of muscle strength, 3 studies with grip strength, and 1 study with eccentric muscle strength. A significant improvement in muscle strength in the eccentric exercise group (SMD, 1.05; 95% CI: 0.78, 1.33) relative to the comparison group was observed. Eccentric exercise combined with adjuvant therapy showed beneficial effects with regard to pain reduction and muscle strength improvement. Comparison between eccentric exercise and other exercises showed positive effects of eccentric exercise with regard to pain reduction; however, the differences in muscle strength and function between the groups were not significant.[208] A similar meta-analysis also published in 2021 found similar results finding that eccentric exercises were more effective when compared to other forms of strengthening and pain-relieving modalities in reducing pain (SMD, 1.12; 95% CI: 0.31, 1.93) and improving function (SMD, 1.22; 95% CI: 0.25, 2.18) in the short term. The evidence for intermediate-term effectiveness was inconclusive for all outcomes.[29]

II A systematic review and meta-analysis of 30 studies[92] evaluated the effectiveness of exercise compared with other nonsurgical interventions in the management of LET on pain and function. In the long term, exercise was better than corticosteroid injection in improving PFGS (MD, 12.15 kg; 95% CI: 1.69, 22.6), pain reduction (SMD, −0.56; 95% CI: −0.78, −0.34), and disability reduction (SMD, −0.64; 95% CI: −0.86, −0.42). Similar observations were noted for short term and the midterm, except for short-term pain reduction. When exercise was compared to a wait-and-see approach, only short-term pain reduction (SMD, −0.33; 95% CI: −0.60, −0.05) and long-term elbow disability (SMD, −0.27; 95% CI: −0.47, −0.06) were statistically significant, in favor of exercise. There is only evidence of low to very low quality to support the effectiveness of exercise over corticosteroid injections and the wait-and-see approach in the long term.[92]

II Hoogvliet et al[82] conducted a systematic review up to February 2010 examining any type of exercise and mobilization techniques compared to a variety of interventions in individuals with LET. High-quality evidence supports the use of stretching plus strengthening exercises for the reduction of pain over the use of therapeutic US and friction massage at 8-week follow-up (SMD, 0.95; 95% CI: 0.26, 1.64).[146] Lower quality, defined as less than 50% on the 12-item source of risk of bias scale, evidence supports the use of progressive strengthening and stretching over US alone for the reduction of pain at an average of 36-month follow-up (MD −3.1 cm; 95% CI: −5.6, −0.5).[144] Low-quality evidence demonstrates no differences in the long-term effect on pain or function (DASH) of stretching alone compared with stretching plus concentric exercises or eccentric exercises at 6-week follow-up.[122] However, significant differences in grip strength in favor of eccentric exercise over contract relax stretching techniques were found at 6-month follow-up but not at 12-month follow-up for chronic LET (Svernlov, 2001).

II Raman et al[150] performed a systematic review pertaining to using any type of strengthening compared to a variety of nonsurgical interventions to

detail specific dosage parameters to guide therapists in the optimal prescription of exercise for individuals with LET. No quantitative data in summary form were reported in this review. Eccentric exercise was the most studied of all resistance types. It is unclear whether strengthening leads to additional improvement of these outcomes in a multimodal treatment regimen due to conflicting results in the studies reviewed. For either isotonic or eccentric strengthening, the following dosing parameters were suggested: 3 sets of 15 repetitions for 6-12 weeks based on moderate evidence. No studies described determination of load or its progression.[150]

II Bisset et al[16] reported on an additional low-quality RCT[163] written in Italian performed in 2003, not included in subsequent systematic reviews. Eccentric exercise plus strengthening in individuals with LET had a significant positive effect on patient satisfaction and return to activity over sham US at 6-month follow-up (relative risk [RR], 21.97; 95% CI: 3.17, 152.20). No harms or adverse effects related to the exercise programs were reported.[16]

V A comprehensive exercise progression algorithm has been proposed for individuals with LET.[43,44] The program is designed to provide exercise dosing guidelines for musculature along the UE kinetic chain in those with LET. Specific criteria are recommended for exercise advancement between 3 phases of the exercise program. Phases 1 and 2 focus on controlled muscle recruitment through a loading progression of isometric, isotonic, and eccentric pain-free contractions using relatively low resistance (between approximately 20%-40% of maximum voluntary isometric contraction [MVIC]) to start. Loading is advanced between phases 2 and 3 by gradually increasing resistance to above 40% MVIC to induce a strengthening response. Further progressions in phase 3 focus on gradually increasing the length of lever arms, UE weight-bearing, and weight or resistance of the exercises. Finally, exercises to re-establish high-level neuromuscular control and anticipatory reactions (eg, UE plyometric exercises) are introduced while incorporating function-specific tasks correcting faulty mechanics as needed into the program.[43,44] It is the opinion of the CPG team that clinicians may incorporate the use of a phased approach to reintroducing stress, increasing strength, improving endurance, and restoring optimal motor control particularly for individuals who have LET symptoms with high-demand occupations, hobbies, performing arts, or athletic interests.

Evidence Synthesis

Despite limitations in study designs including the lack of placebo control groups in many studies and the lack of uniformity in exercise and dosage parameters, it does appear that both concentric and eccentric resistance exercises have a positive effect on pain intensity, PFGS, and function compared to other nonsurgical interventions. No studies described how load was determined or how it was progressed. Unsupervised daily isometric progressive resisted exercises to the wrist extensors have also been shown to be effective in reducing pain and disability over no intervention for individuals with 6 or more weeks of LET symptoms. Stretching of the wrist extensors alone appears to have no long-term effect on pain or function compared to stretching plus concentric or eccentric strengthening to the wrist extensors at the midterm. At 1-year follow-up, eccentric strengthening to the wrist extensors may be more effective at reducing pain and increasing strength when compared to concentric exercises. Based on the best available evidence and expert opinion, either isometric, isotonic, or eccentric strengthening of the wrist extensors may be prescribed using the following suggested dosing parameters: 3 sets of 15 repetitions for 6-12 weeks. However, loads that are applied should not exacerbate symptoms and loading should be progressed from isometric to isotonic and from isotonic to eccentric as tolerated without exacerbation of symptoms. No adverse effects of any type of exercise were reported in these studies.

Published research studies provide little information regarding specific rehabilitation guidelines that optimize return to function while minimizing risk of recurrent symptoms in individuals with LET. Based on expert opinion, a phased approach to reintroducing stress, increasing strength, improving endurance, and restoring optimal motor control may be appropriate for individuals who have LET symptoms with high-demand occupations, hobbies, performing arts, or athletic interests.

Gaps in Knowledge

Although eccentric exercises to the wrist extensors were the most studied of all resistance types, more evidence is needed on which type of strengthening, which muscle groups should be addressed along the UE kinetic chain, and which dosage parameters are most effective in improving outcomes for LET. Specifically, studies are needed to determine optimal loading and its progression. Comparison to true control groups is needed to discern the effects of natural history and/or placebo. Additionally, examination of the effects of exercise on various naturally occurring subgroups (based on acuity and irritability, presence or absence of periscapular dysfunction, etc) of individuals with LET is needed. Large, high-quality RCTs with clearly defined strengthening regimes are needed to determine optimal dosage to maximize treatment effect. It is unclear whether exercise in isolation is more effective than other treatment such as manual therapy.

While CPG team members recommend the use of a phased re-introduction of strengthening, endurance training, and

high-level neuromuscular re-education for the return-to-function phase of rehabilitation, research studies that examine the effectiveness of these exercise strategies and progressions in those with LET who have high-demand occupations, hobbies, performing arts, or athletic performance requirements are needed.

RECOMMENDATION

B Clinicians should use isometric, concentric, and/or eccentric therapeutic resisted exercises of the wrist extensors in the treatment of individuals with subacute or chronic LET.

F Clinicians may use a phased approach to reintroduce stress, increase strength, improve endurance, and restore optimal motor control in individuals who have LET symptoms with high-demand occupations, hobbies, performing arts, or athletic interests.

MULTIMODAL INTERVENTIONS INCLUDING EXERCISE

I Mostafee et al[127] completed an RCT to compare the effects of shoulder and scapular muscle training plus multimodal physical therapy consisting of transcutaneous electrical nerve stimulation (TENS), US, deep friction massage (DFM), and a combination of isometric and isotonic strengthening of the wrist extensors with a group who received multimodal physical therapy only. Forty-eight patients with LET were randomly allocated to the 2 groups and received treatment for 4 weeks. The primary outcomes were pain measured using VAS, PFGS, and self-reported function (PRTEE and QuickDASH). The program that combined multimodal physical therapy with shoulder and scapular muscle training was more effective in improving pain (MD, 2.20; 95% CI: 1.32, 3.09) and function using the PRTEE (MD, 21.25; 95% CI: 11.07, 31.43) and QuickDASH (MD, 15.36; 95% CI: 5.94, 24.78), when compared with multimodal physical therapy at 4-month follow-up.

II Day and Lucado[43] randomized 35 patients with a clinical presentation of LET into 2 groups: local therapy (LT) and local therapy plus scapular muscle strengthening (LT+SMS). The LT protocol included education, counterforce bracing, physical agents, manual therapy, and therapeutic exercise, whereas the LT+SMS treatment included the same but with scapular muscle strengthening. The PRTEE was the main outcome measure collected at baseline, 4-6 weeks, and 6- and 12-month follow-up. There was a significant main effect for time for the PRTEE measures of both pain and function. Ultimately, both groups changed at the same rate (average PTREE pain LT at evaluation = 20.50 points; 95% CI: 17.05, 23.95 at discharge = 6.79 points; 95% CI: 3.57, 10.0. Average PTREE pain LT+SMS at evaluation = 20.78 points; 95% CI: 16.41, 25.14 at discharge = 9.41 points 95% CI: 6.22,12.61). There was no significant difference between groups from evaluation to discharge (average visits = 8 +/– 2.2 over 4-6 weeks). Following discharge, pain and functional gains were maintained, suggesting that the interventions had positive long-term effects in both groups.[43] The addition of scapular muscle strengthening does not appear to add value for improving pain and function in the context of a multimodal treatment program.

II Twelve clinical trials of varying quality were included in a systematic review of eccentric exercise in combination with other treatments compared to reference groups not receiving eccentric exercise as a part of the treatment.[39] Data were not pooled due to the variability in measurement methods of the outcomes, and insufficient evidence was available to estimate. When compared to other treatment therapies, qualitative assessment of the evidence supports the use of multimodal treatment programs including eccentric exercise for improving pain and function in the midterm management of LET (less than 24 weeks after discharge).[39]

II Olaussen et al[137] performed a systematic review and meta-analysis of RCTs on the effectiveness of corticosteroid injection and nonelectrotherapeutic therapy compared with control for treating LET. Eleven RCTs were included in the review assessing RR or for overall improvement, pain, and grip strength at 4-, 12-, 26-, and 52-week follow-up. Corticosteroid injection and MWM along with exercise gave a short-term benefit (4-12 weeks) in overall improvement compared with control with RR of 2.27 (95% CI: 1.04, 4.97) and 2.75 (2.09, 3.62), respectively. However, for the intermediate term (3-6 months), outcomes for individuals treated with corticosteroid injections were worse (0.66; 0.53, 0.81), whereas MWM with exercise was not different from control (0.99; 0.75, 1.30). In the long term (greater than 6 months), both treatments showed no benefit over control.[137] One study showed a short-term positive effect on pain (SMD, 4.45; 95% CI: 3.51, 5.40) and grip strength (SMD, 3.16; 95% CI: 2.40, 3.92) for eccentric exercises and stretching.[163] Long-term follow-up also showed a positive effect on pain (SMD, 4.65; 95% CI: 3.68, 5.63) and grip strength (SMD, 3.65; 95% CI: 2.82, 4.47).[163]

II Sethi et al[164] conducted an RCT examining the effect of scapular muscle strengthening plus physical therapy addressing the elbow/wrist region (n = 13) with physical therapy only addressing the elbow/wrist region (n = 13) for 3 times a week for 6 weeks on pain (VAS), PFGS, function (PRTEE), scapular muscle strength, scapular positioning, and electromyography in adults with chronic LET. Both groups received multimodal physical therapy while the

experimental group also received a scapular muscle strengthening protocol. The scapular muscle strengthening group demonstrated greater improvement than the other group for all outcomes except scapular positioning over the 6 weeks. The ultimate positive effect (d) of scapular muscle strengthening when added to physical therapy addressing the elbow/wrist region on pain (d = 0.29), PFGS (d = 0.36), and function (d = 0.18) was small, while the effect on scapular strength was moderate, ranging from 0.57 to 0.68.[164]

II Coombes et al[38] conducted a cost effectiveness analysis comparing a multimodal intervention, including exercise and corticosteroid injections over a 1-year period in participants with LET symptoms greater than 6 weeks. Participants were randomly allocated into 1 of 4 groups: saline injection (n = 39), corticosteroid injection (n = 40), exercise + saline (n = 39), and exercise +corticosteroid (n = 36). All participants received 1 injection and standardized advice on resting for 10 days followed by a gradual return to activity. The participants allocated to exercise received a standard protocol of manual therapy at the elbow with gripping, concentric and eccentric wrist exercises, motor control retraining, and global UE strengthening exercises. The exercise intervention had greater initial costs but was the only intervention that resulted in significantly greater quality of life after 1-year. The probability of being more cost effective than placebo was 81% for including exercise, 53% for corticosteroid, and 24% for the combination corticosteroid+exercise.[38]

Evidence Synthesis

Several studies demonstrate a positive short-term but no net long-term effect of wrist extensor strengthening plus elbow joint mobilization/manipulation on outcomes compared to control groups. A few studies demonstrate eccentric strengthening, and stretching of the wrist extensors appears to produce positive gains compared to other forms of physical therapy intervention. The efficacy of wrist extensor strengthening exercises on reducing pain and disability may be enhanced by the addition of manual therapy, including MWM or Mill's manipulation techniques, to the elbow. However, the evidence for the duration of patient-reported improvements is limited to less than 24 weeks. The probability of being more cost effective was highest in individuals receiving a multimodal physical therapy treatment including exercise compared with a "wait-and-see" control group or cortisone injection groups.

Additionally, weak evidence supports the use of shoulder and scapula muscle training exercises in conjunction with other forms of localized isotonic exercises and stretching. The published literature provides little information regarding specific rehabilitation guidelines that address optimizing return to function while minimizing risk of recurrent symptoms in individuals with LET. No harm or adverse effects were reported in the studies describing exercise in the context of a multimodal treatment approach.

Gaps in Knowledge

Given the variety of treatments included in the multimodal physical therapy approaches described in these studies, the effect of specific and standardized multimodal treatment combinations is not clear. Classification subgroups of individuals who most benefit from multimodal treatments plus exercise have not been elucidated in the literature. The muscle groups included, and the optimal type(s) and dosage parameters of exercise are not yet known for the successful treatment of LET. More studies comparing interventions to true control groups are needed.

RECOMMENDATION

B Clinicians should use therapeutic resisted wrist extension strengthening exercises in combination with other therapeutic interventions, including manual therapy, in the treatment of patients with subacute or chronic LET.

C Clinicians may include shoulder and scapular stabilizer muscle training exercises, when impairments are identified, in conjunction with other forms of localized resisted exercises in individuals with LET.

MANUAL THERAPY JOINT MOBILIZATIONS/ MANIPULATIONS

II Lucado et al[111] conducted a meta-analysis of clinical trials that examined the effect of joint mobilizations on pain, grip strength, and disability in adults diagnosed with LET. Twenty studies of varying quality met the inclusion criteria and broadly comprises studies examining the effects of either a lateral glide MWM technique to the elbow, Mill's manipulation, or regional mobilization techniques. Only 7 trials were appropriate for the meta-analysis. The MWM technique to the elbow demonstrated a moderate positive mean effect (SMD, 0.43; 95% CI: 0.15, 0.71) on pain and a moderate positive effect on PFGS (SMD, 0.31; 95% CI: 0.11, 0.51). One study reported a moderate positive effect (SMD, 0.77; 95% CI: 0.81, 1.37) of MWM on pain and disability compared to groups receiving placebo or other nonsurgical interventions as measured by the PRTEE in the short term.[35] Mill's manipulation technique to the elbow demonstrated a moderate positive effect (SMD, 0.47; 95% CI: 0.11, 0.82) on pain (VAS), but no appreciable effect (SMD, 0.01; 95% CI: −0.27, 0.26) on PFGS. Regional mobilization, including cervical manipulation[59,60] or side glides[194] to C5-6, cervical or thoracic mobilization,[34] ventral scaphoid manipulation to the wrist,[89,181] and radial head manipulation,[84] each demonstrated effectiveness over control groups

in reducing pain, increasing grip strength, and improving function in the short term.[111]

II Hoogvliet et al[82] conducted a systematic review examining the use of exercise therapy and mobilization techniques for the treatment of lateral and medial elbow tendinopathy; 1 systematic review and 12 RCTs met the inclusion criteria. There was conflicting evidence for the effectiveness of manipulation of the cervical spine compared with a placebo or control group for improving pain and functional outcome immediately after treatment. Moderate quality evidence supported the benefit on PFGS when using manipulation of the cervical and thoracic spine as an adjunct to concentric and eccentric exercises and mobilization of the wrist and forearm at 6 weeks (MD, 14.6 kg; 95% CI: 9.3, 19.9) and at 6 months (MD, 19.6 kg; 95% CI: 1.6, 37.6) compared with local treatment only. There was limited evidence that manipulation of the wrist has a positive impact on pain when compared with a group who received US plus friction massage, stretching, and strengthening exercises for the wrist extensors at 6-week follow-up. Local mobilization or manipulation to the elbow were also examined in the review. There was limited evidence for the short-term effectiveness on outcomes as a result of using MWM as an adjunct to US and progressive resisted exercise and when comparing the technique to a placebo or control treatment ($P<.05$, no exact data given).[82]

II Bisset at al[16] found low-quality evidence that supported MWM of the elbow for improving PFGS immediately compared with a sham mobilization (SMD, 1.28; 95% CI: 0.84, 1.73). Low-quality evidence also supports elbow manipulation when combined with US for reducing pain at 3 weeks ($P<.01$) and at 12 weeks ($P<.05$). Studies that included mobilizations as a multimodal treatment to improve pain, global improvement, and function were of higher quality.[16]

II In the low-quality, qualitative systematic review by Herd and Meserve,[77] one reviewer assessed the quality of the 13 articles that met the inclusion criteria. In the studies examining the effects of manipulative therapy on adults with LET, it appears that MWM offers both short- and long-term benefit in reducing pain and increasing function and that both cervical and wrist manipulation improved short-term outcomes.[77]

II In an RCT, Akbar et al[3] compared Cyriax manual therapy to Mulligan's MWM intervention measuring both pain and grip strength. Sixty-six participants between the ages of 20-50 years old diagnosed with LET from an orthopaedic physician were included in the study. Pain (0-10) after 8 weeks of treatment was found to be significantly decreased in both groups, mean (SD) 1.93 ± 0.74 and 1.70 ± 0.79, respectively ($P = .2$). Grip strength results at posttreatment level for the Cyriax and Mulligan MWM groups were 53.5 lbs ± 2.13 and 42.3 lbs ± 1.97, respectively ($P<.01$). After 8 weeks of treatment, Cyriax manual therapy and Mulligan's MWM intervention were both equally effective in improving pain; however, because there was no control group, the improvements made in both groups could have been due to the passage of time. Cyriax manual therapy improved grip strength more than the Mulligan technique.[3]

II In an RCT, the effects of an MWM lateral glide technique to the elbow (n = 20) were compared to the effects of a standard physical therapy program (n = 20) on pain (VAS), PFGS, and function (PRTEE) in adults with LET.[151] Both groups received a standardized program of exercise, cryotherapy, and education 5 days a week for 2 weeks. In addition, the experimental group received MWM lateral glides to the elbow. At 12 weeks, between-group differences in PFGS were significant ($P<.05$) with higher values in the experimental group (mean, SD) 29.60 kg ± 8.85 compared to the control group 26.47 kg ± 9.58. Between-group differences in PRTEE were also significant, in favor of the experimental group receiving MWM (MD, −15.00 points; 95% CI: −35.00, −10.00) compared with the control group (MD, −16.50 points; 95% CI: −38.00, −12.00). The addition of the MWM lateral glide technique to exercise, cryotherapy, and education appears to have a small positive effect on PFGS and pain and function, as measured by the PRTEE.[151]

II Zunke et al[210] completed an RCT to investigate the effect of manual therapy to the thoracic spine on PFGS and sympathetic activity in patients. Patients with pain duration of less than 6 months were randomly allocated to either the thoracic spine mobilization group (n = 15) where they received a one-time 2-minute T5 costovertebral mobilization (2 Hz), or a placebo group (n = 15) who received a one-time 2-minute sham US therapy. The outcomes measured were PFGS, skin conductance, and peripheral skin temperature. The thoracic spine mobilization group demonstrated a significant increase in PFGS 4.6 kg (95% CI: 1.8, 6.92 kg) when compared to the control group. A thoracic costovertebral T5 mobilization at a frequency of 2 Hz had an immediate positive effect on PFGS and sympathetic activity in patients with LET.[210]

Evidence Synthesis

A preponderance of level 2 evidence demonstrates that lateral glide MWM technique to the elbow, Mill's manipulation technique, or regional mobilization techniques all demonstrate a positive effect compared with a placebo or control group on pain, PFGS, and function in the short term. The

MWM technique described is performed with the clinician providing a lateral glide of the proximal forearm on a stabilized humerus while the patient (in supine, elbow extended, and forearm pronated) performs an active pain-free gripping action. Mobilization with movement is often administered with 6-10 repetitions of the glide for 3-5 sets in 1 treatment session. The Mill's manipulation technique described is performed with high-velocity, low-amplitude thrust manipulation into elbow extension while the individual is seated and the shoulder is held in abduction and internal rotation, the forearm is in pronation, and the wrist is in flexion. Mill's manipulation is performed once in a treatment session. Numerous regional mobilization techniques are described at the thoracic or cervical spine, radial head, or the wrist for those with identified impairments in those regions. As long as these techniques are providing symptom relief, they may be repeated at subsequent visits (8-12 visits over a time period of 4-8 weeks have been described most commonly). The short-term effectiveness that mobilizations have on individuals with pain and pain-limited function associated with LET lasting more than 2 weeks may point toward the role that the nervous system sensitization has on the presentation of LET. No adverse effects or harms were reported.

Gaps in Knowledge

The current literature does not address which type of joint mobilization technique is superior to others. The midterm and long-term outcomes of joint mobilization on outcomes in LET are unknown. Joint mobilizations/manipulations may contribute to diminishing pain and improving motor function via neurophysiologic mechanisms. Although these mechanisms are not completely understood, joint mobilizations/manipulations may involve reflex inhibition of pain mediated through joint mechanoreceptors.

RECOMMENDATION

B Clinicians should use local elbow joint manipulation or mobilization techniques to reduce pain and increase PFGS in individuals with LET as a standalone or adjunctive treatment in improving short-term outcomes for those who can tolerate the specific technique.

C Clinicians may use manipulation or mobilization techniques directed at the cervical spine, thoracic spine, and/or wrist as an adjunct to local treatment for short-term pain relief in individuals with LET when impairments in those regions are identified.

MANUAL THERAPY SOFT TISSUE MOBILIZATIONS

II Laimi et al[101] compiled a systematic review of RCTs to evaluate the evidence related to the effectiveness of myofascial release therapy (MRT) to relieve chronic musculoskeletal pain and to improve joint mobility, functioning level, and quality of life. Myofascial release therapy was defined as any of the following: direct pressure MRT releases, indirect "stretching" MRT releases, and self-MRT releases. The authors excluded techniques on trigger point therapy or releases. Related to LET, the authors found 2 RCTs[2,95] (n = 95) that met the criteria. The raw mean difference in PRTEE improvement between the control and LET group was (−47 points; 95% CI: −44.64, −49.36)[2] and (−19.3 points; 95% CI: −22.92, −15.68),[95] both in favor of the MRT group.[101]

II Yi et al[207] examined the effects of a 1-time DFM coupled with a local lidocaine injection in patients with LET symptoms >6 weeks. The authors randomly allocated treatment into 3 groups; splinting and stretching, cortisone injection, and DFM plus lidocaine injection. Along with the above individual treatments, all groups received a standardized ROM exercise protocol. Only the group receiving DFM plus lidocaine injection demonstrated significant improvements in outcomes at the 6-month follow-up compared to the other 2 groups. Although the sample size was small (total n = 17) for the follow-up data, there was a statistically significant greater effect on VAS, DASH, and grip strength ($P<.05$) for the DFM plus lidocaine injection group at 6 months compared with the other 2 groups.[207] No between-group comparison data were given other than P value for analysis of variance (ANOVA). The use of DFM appears to hold some merit for midterm functional outcomes, but the simultaneous lidocaine intervention likely played a large role in its effect and may not be feasible for most physical therapists.

II Sevier and Stegink-Jansen[165] randomized 113 patients with clinical signs of chronic (symptoms lasting more than 12 weeks) LET into 2 groups. Both groups were prescribed eccentric exercises for the common wrist extensors, but the experimental group also received instrument-assisted soft tissue mobilization. DASH and pain VAS (0-100) were collected at baseline, 6 weeks, and 6- and 12-month follow-up. Participants in the instrument-assisted soft tissue mobilization group demonstrated greater gains in the DASH (standardized ES, 0.40; 95% CI: 0.00, 0.84) and grip strength (standardized ES, 0.62; 95% CI: 0.16, 1.07) compared to the eccentric strengthening group at 6 weeks. However, there were no differences between the groups at 6- and 12-month follow-up; no adverse effects were reported.[165] The primary investigator declared a conflict of interest being the Medical Director of the instruments used in the study.

II Loew et al[110] conducted a systematic review of RCTs comparing deep transverse tendon cross-friction massage to control groups or groups with other active interventions. The authors reviewed 2 low-quality

studies, one of which included an RCT on nonsurgical treatments for common wrist extensor tendinopathy. Pooled MDs of the VAS for pain and function scales (0-100) with 95% CIs were assessed. The mean difference between groups in pain was −6.6 mm (−28.6, 15.4) and in function was −1.8 points (−18.6, 15.04) showing no difference between interventions. Adverse events and withdrawals due to adverse events were not assessed or reported.[110]

II Blanchette et al[19] documented, in their pilot study, no difference in improvements of PFGS, pain, and function between a control group (n = 12) and a group receiving instrument-assisted soft tissue mobilization (n = 15) after 6 weeks. The control group received education and advice on strategies to reduce stresses to the lateral elbow, while the experimental group received the instrument-assisted soft tissue mobilization twice a week for 5 weeks. No adverse effects were noted other than temporary bruises. Upon critical review, it was observed that the study was underpowered and needed a total of 116 participants to achieve a power of .80.[19]

Evidence Synthesis

A variety of soft tissue techniques were examined in these few studies. Two low-quality studies have demonstrated positive effects of MRT on pain and function in individuals with chronic LET. Manual release therapy was administered with and without other physical therapy treatments 3 times a week for 4 weeks. Manual release therapy may decrease pain and improve function in individuals with chronic LET. There seems to be a benefit when instrument-assisted soft tissue mobilization is added to exercise, but not as a stand-alone treatment to improve pain and functional status for patients with LET. Deep friction massage does not appear to be an effective intervention as a stand-alone treatment to improve symptoms in individuals with LET, but it may be beneficial when included with a lidocaine injection. Deep transverse tendon cross-friction massage does not appear to improve pain and function when compared to other treatments. While the potential benefits include improvement in pain and function, harms include temporary bruising following treatment. No study related to soft tissue mobilization reported serious adverse effects.

Gaps in Knowledge

Given the variety of soft tissue techniques available to physical therapists to use for treatment of tendinopathy, there is a need for high-quality RCTs comparing specific, clearly operationalized, manual therapy soft tissue techniques against a true control group while using homogenous outcome measures. The characteristics of those individuals who would benefit most from soft tissue techniques also need to be determined. Insufficient evidence is available regarding the dosage of soft tissue manual therapy techniques and the midterm to long-term impact of these techniques on symptoms of LET.

RECOMMENDATION

C Clinicians may use soft tissue mobilizations, including MRT, to improve pain and function in individuals with chronic LET.

C Clinicians may use instrument-assisted soft tissue mobilization combined with exercise to improve pain and function in those with chronic LET.

D Based on conflicting evidence, a recommendation cannot be made regarding the use of deep transverse tendon cross-friction massage to alleviate symptoms in individuals with LET.

DRY NEEDLING

I Ugyur et al[187] completed an RCT (n = 108) to compare the effectiveness of dry needling (DN) near the lateral epicondyle and throughout the ECRB muscle and corticosteroid injection (CS) in the management of LET. The PRTEE measuring pain and function was administered at baseline, 3 weeks, and 6 months. Dry needling was more effective than CS (P<.01) at the 3-week and 6-month follow-up and with fewer complications. No ESs were reported. Complications from CS included skin atrophy and whitening (4 individuals), and there was 1 individual who withdrew from the study because of pain with the DN procedure.

I Rodríguez-Huguet et al[152] completed an RCT that compared adding trigger point dry needling (TDN) or percutaneous electrolysis (PE) to eccentric exercises in the treatment of LET. Thirty-two participants were randomly allocated to either group 1 (n = 16) that received 4 sessions of PE or group 2 (n = 16) that received 4 sessions of TDN. The PE treatment consisted of the delivery of continuous galvanic current with intensity of 350 microamps to the common extensor tendon (guided by US) at the elbow using an acupuncture needle for 1.2 minutes. Pain (NPRS), PPT, quality of life, and ROM were measured at baseline, at the end of treatment, and at 1- and 3-month follow-ups. The effect (eta-squared) on pain reduction (n^2 = 0.46) was moderate, and improved PPT (n^2 = 0.11) was small in all 3 follow-ups in favor of the PE groups (P<.05). Percutaneous electrolysis could be superior to TDN when added to an eccentric exercise program in the management of LET after a 3-month follow-up. Complications and adverse effects were not reported or discussed.

II Navarro-Santana et al[129] completed a meta-analysis to evaluate the effect of any type of DN alone or combined with other treatment interventions on

pain, related-disability, pressure pain sensitivity, and strength in LET. This meta-analysis included 320 patients from 7 moderate quality studies. Dry needling facilitated a decrease in pain (SMD, −1.13; 95% CI: −1.64, −0.62), decrease in disability (SMD, −2.17; 95% CI: −3.34, −1.01), and increase in PPT (SMD, 0.98; 95% CI: 0.30, 1.67) with larger ESs mainly in the short term when compared to the control group. One study specifically examined tendon DN, which demonstrated a large effect on function (MD, −15.91 points; 95% CI: −27.28, −4.54; SMD, −0.81) compared with a standard physical therapy group consisting of US, DFM, and exercise.[56] Grip strength improved when compared to the control group but with a small effect (SMD, 0.48; 95% CI: 0.16, 0.81). There was considerable heterogeneity across all studies, but overall, there was positive effect of DN on LET symptoms in the shorter term. These results were similar to the findings of a 2015 systematic review examining tendon DN.[100]

Evidence Synthesis

There is moderate evidence to suggest that a variety of DN procedures alone and in conjunction with other therapies reduces pain and improves function in individuals with LET and associated trigger points. However, PE demonstrated a moderate positive effect on pain and PPT over TDN when both treatments were combined with eccentric exercise. There is not sufficient evidence to confidently outline the optimal dosage parameters, needling technique, or depth of insertion due to the variety of techniques used in the various studies. Frequency of treatment varied from a one-time session to up to between 2 and 3 times a week for up to 3 weeks. The available studies suggest minimal to no harmful side effects of the procedure to treat symptoms of LET; however, those with a fear of needles may not tolerate this treatment.

Gaps in Knowledge

More high-quality evidence is needed examining the efficacy of both tendon and TDN on symptoms of LET compared with a true control group. More clear evidence is needed on the characteristics of the individuals with LET that would most benefit from the different DN techniques. Studies should clearly operationalize the DN technique and dosage parameters used. The long-term effect of DN on symptoms in patients with LET is unknown.

RECOMMENDATION

B Clinicians should use either tendon or TDN for the treatment of pain and functional deficits associated with LET.

ORTHOSES

II Shahabi et al[167] conducted a meta-analysis that included 17 studies (most of low quality), with 1145 participants with LET examining the effect of a lateral counterforce orthosis on pain. In the short term, the counterforce orthosis did not have a statistically significant effect (SMD, 0.02; 95% CI: −0.85, 0.80) on pain compared with other physical therapy interventions for all patients. Similarly, in younger patients (<45 years), there was no statistically significant effect on pain (SMD, −0.86; 95% CI: −2.45, 0.72). In the long term, other physical therapy interventions seemed to have a greater positive effect than the counterforce orthosis as a stand-alone treatment (SMD, 1.17; 95% CI: 0.00, 2.34).[167] Similar results supporting the use of other physical therapy interventions over the use of a counterforce orthosis alone to improve pain and function were also reported in an earlier systematic review.[16]

II Heales et al[73] completed a systematic review to evaluate the immediate effect of forearm counterforce and wrist support orthoses on pain and strength in individuals with LET. They included 7 randomized crossover trials in their review. Low-quality evidence is available to support a significant decrease in pain during contraction (SMD range: −0.83 to −0.65) and improvements in PFGS (SMD range: 0.24-0.38) with a forearm counterforce orthosis compared to a control or placebo. Borkholder et al[21] also found, in their systematic review including 11 low quality studies, that use of a counterforce brace, regardless of style, resulted in increased grip and wrist extensor strength in symptomatic individuals. In participants wearing a wrist support orthosis, the difference in pain decrease during extensor muscle contraction was greater than in those using a placebo orthosis (MD, −0.48 cm; 95% CI: −0.96, −0.01).[73] Use of a wrist support orthosis has also demonstrated reductions in wrist extensor muscle activity in normal individuals.[21] Both systematic reviews supported the use of a counterforce orthosis to provide an immediate decrease in pain and an increase in PFGS; both reviews reported reduction in pain with contraction, with the use of a wrist support orthosis in participants with LET.[21,73] However, the participants' gripping ability was impaired while using a wrist support orthosis.[21,73]

II Healy et al[74] reported on 2 studies examining the difference between a laser intervention and forearm counterforce orthosis application. One study[136] reported a greater reduction in pain in a group receiving laser when compared to a group receiving a forearm counterforce orthosis (ES, 1.04; 95% CI: 0.35, 1.73), whereas a more recent study[53] reported that a group receiving a forearm counterforce orthosis demonstrated greater reduction of pain than a group receiving sham laser therapy (ES, −0.8; 95% CI: −1.45, −0.15). The systematic review calculated the odds of treatment success for a group receiving a forearm counterforce orthosis alone compared to a group receiving the orthosis plus physical therapy, which was not statistically different

between groups (OR = 1.44; 95% CI: 0.49, 4.23) at 26 and 52 weeks.

II The systematic review by Bisset et al[16] demonstrated that cortisone injections had a better effect than either type of orthosis (forearm counterforce or wrist support) in the short term (RR, 2.9; 95% CI: 1.8, 5.7) on global improvement scores; however, there was no difference in effect on global improvement scores at the intermediate (RR, 0.70; 95% CI: 0.46, 1.05) or long term (RR, 0.90; 95% CI: 0.60, 1.03) time frames.[16] Similar results have been reported in another systematic review.[172] However, the use of a forearm counterforce orthosis was more effective in enabling a group of individuals with LET to perform daily activities in the short term when compared to a group receiving pulsed US plus friction massage and exercise measured on an activity improvement scale ranging from 0 to 100 (MD,11 points; 95% CI: 1, 21).[16]

V A survey of practice patterns of hand therapists (n = 693) revealed that 81% of respondents utilized either a forearm counterforce or wrist support orthosis for immediate pain relief in individuals with LET whose pain was aggravated with activities.[115] It is the opinion of the CPG team that clinicians may incorporate the use of either a forearm counterforce or wrist support orthosis for individuals who have LET symptoms with high irritability and difficulty performing functional activities while they are active; as long as it is comfortable, it diminishes their pain and it improves their function.

Evidence Synthesis

There is conflicting evidence on whether the use of an orthosis alone (forearm counterforce or wrist support orthosis) or as adjunct with other treatments provides relief of symptoms related to LET according to published systematic reviews. As a stand-alone treatment, the use of an orthosis does not appear to be as effective in improving pain and function when compared to other physical therapy intervention or cortisone injections in the long term, although conflicting evidence exists regarding its benefit compared with laser application. The odds for success were no different whether the orthosis was administered alone or as an adjunct to physical therapy interventions in the midterm and long-term time points.

However, use of a forearm counterforce orthosis appears to diminish pain severity and strength in the immediate term compared with a sham counterforce orthosis. The use of a forearm counterforce orthosis may be more effective in enabling individuals with LET to perform daily activities in the short term when compared to US plus friction massage plus exercise. Use of a wrist support orthosis has been shown to improve pain and decrease muscle activity in the wrist extensors in the immediate term. Although some reported a decreased ability to grasp with use of a wrist support orthosis no studies reported any adverse effects of either counterforce or wrist support orthoses. It should be noted that the reported studies included individuals with symptom duration between 6 weeks and 12 months. Based on expert opinion, a forearm counterforce or wrist support orthosis may be appropriate for individuals who have LET symptoms with high irritability and difficulty performing functional activities.

Gaps in Knowledge

Future studies will need to consistently include a true control group comparison to ascertain the effect of orthoses on pain, strength, and function in those with LET. Characteristics of those individuals who would most benefit from orthosis interventions need to be studied to determine the true utility of the forearm counterforce or wrist support orthosis according to their irritability of symptoms. The use of similar research designs and outcomes will facilitate statistical pooling of the data to enable more definitive recommendations. While CPG team members recommend the short-term (2-4 weeks) use of either a forearm counterforce or a wrist support orthosis for individuals who have highly irritable symptoms of LET, further research studies are needed that include that subgroup of participants.

RECOMMENDATION

D Based on conflicting evidence, a recommendation cannot be made regarding the use of a forearm counterforce or wrist support orthosis to alleviate intermediate or long-term symptoms in individuals with LET.

F Clinicians may use a forearm counterforce or wrist support orthosis to be worn during activity for immediate improvement of pain and strength in those with LET whose symptoms are aggravated with activity.

TAPING

Two main types of tape and numerous therapeutic taping techniques are described in the literature. Tape with elastic properties, such as generic kinesiology tape, theoretically decreases pain through cutaneous stimulation, which is thought to alter pain mechanisms and may improve proprioception.[63] Rigid tape is a tape with no elastic properties that provides support that is primarily thought to help off-load tissues, particularly for LET, the wrist extensor muscle group. A variety of techniques of tape application has been used each with the authors' purported goal of either pain relief, off-loading tissue, stimulating or inhibiting muscle function, and/or improving movement patterns.[63]

I Zhong et al[209] conducted a meta-analysis to evaluate the efficacy and safety of kinesiology tape for improving outcomes in patients with LET. Five studies with low risk of bias were included and included 168 patients who either received kinesiology tape or a control condition. There were improvements in pain (weighted mean difference [WMD]: −0.46; 95% CI: −0.90, −0.02), grip strength (WMD, 1.63; 95% CI: 0.27, 3.00), function as measured by the Modified Mayo Performance Index (WMD, 4.23; 95% CI: 2.80, 5.65), and function as measured by the DASH score (WMD, −5.25; 95% CI: −9.10, −1.39) in the kinesiology tape group over the control groups. Each trial included in the meta-analysis reported skin irritation; however, the calculated risk difference in the meta-analysis (0.022; 95% CI: −0.049, 0.092) did not demonstrate an increase in risk of skin irritation.[209]

I Bisset et al[17] included 1 high-quality study in their meta-analysis that examined the immediate effects of a rigid taping technique on pain and grip strength in a single-blinded placebo-controlled randomized crossover design.[194] Sixteen individuals (mean duration of symptoms >1 year) were randomly allocated to 1 of 3 rigid taping conditions, rigid diamond-deloading taping, placebo rigid tape, and no tape. Pain-free grip strength and PPT were measured before, immediately after, and 30 minutes after each taping technique. Pain-free grip strength increased 24% from baseline in the rigid diamond-deloading taping group, which was significant compared with the placebo and no-taping groups. Improvements in PPT were statistically significant in the rigid diamond-deloading taping group compared with the control group, but not statistically significant when compared to the placebo group. Based on the one study, rigid taping in the shape of a diamond over the lateral epicondyle to deload the wrist extensor muscles for the treatment of LET has been demonstrated to improve PFGS in the immediate and short term.[17]

II The evidence on the efficacy of the therapeutic tape in the management of LET was systematically reviewed.[63] The final review included 8 studies, with risk of bias ranging from low to high, which examined rigid taping, kinesiology tape, and placebo taping techniques. The immediate- and short-term improvements of rigid strapping on pain and grip strength were generally higher when compared to kinesiology tape and placebo. Rigid diamond-deloading taping technique demonstrated significantly greater improvement in strength outcomes compared with unaffected extremities in multiple studies.[168,169,194] Transverse rigid taping technique demonstrated significantly greater improvement in joint position and force reproduction error than healthy extremities. Most studies did not report adverse effects; one study reported no adverse effects.[105] The data were presented as percent change in outcomes and unable to be pooled. There is evidence to support the immediate effectiveness of the tape on pain and grip strength. However, there is conflicting evidence on the medium- and long-term effectiveness of the therapeutic tape.

II Özmen et al[139] completed an RCT of 40 patients clinically diagnosed with LET to compare the clinical and sonographic effects of US therapy, ESWT, and kinesiology tape in LET. The VAS, PRTEE, and grip strength were measured at baseline, 2 weeks, and 8 weeks. The VAS score improved in all groups significantly ($P<.05$). Only the kinesiology tape groups showed significantly increased grip strength at the 8-week follow-up ($P<.05$). PRTEE scores significantly decreased after 2 weeks and after 8 weeks in the US group and ESWT groups, and after 8 weeks in the kinesiology tape group ($P<.05$). However, at 8-week follow-up, no significant differences in improvements in pain, function, or grip strength were demonstrated between any of the groups.

II Martínez-Beltrán et al[121] investigated the application of kinesiology tape on wrist extensor isometric muscle strength and grip, isokinetic pronation and supination strength, and the time it took to reach that strength in patients with at least 3 months duration of LET symptoms. This one-time intervention included kinesiology tape using "I" muscle toning technique applied from lateral epicondyle to wrist for the experimental group and tape placebo using a 5-cm-wide white athletic bandage with no tension applied for the comparison group. Overall, there was no immediate effect noted across all the outcome measures with the application of kinesiology and placebo tape ($P>.05$ for all comparisons). The application of kinesiology tape alone was not immediately effective in wrist extensor or grip facilitation in those with LET.[121]

II Eighty-seven individuals with a clinical diagnosis of LET and duration of symptoms of at least 3 months were randomized into either a control group or kinesiology tape experimental group.[118] Both groups took oral naproxen and were instructed in activity modification and a home exercise program. Additionally, in the kinesiology tape group, the tape was applied 3 times a week for 2 weeks for a total of 6 sessions using inhibitor (tape placed at the radial styloid process to the lateral epicondyle with 25% tension) and mechanical correction (tape stretched with 50%-75% tension targeting the most painful area, and the remaining placed without stretching) taping techniques. Clinical (VAS, PRTEE) and ultrasonographical (common extensor tendon thickness, radial nerve cross-sectional area) measures were assessed before and after treatment (second week, sixth week, and 14th week). The common extensor tendon thickness and

radial nerve cross-sectional area at the level of prebifurcation significantly improved (decreased) for the kinesiology tape group compared to the control group at the second, sixth, and 14th weeks ($P<.001$). In the kinesiology tape group, the decrease in VAS, PRTEE-pain, and PRTEE function was significant for the fourteenth week ($P<.001$) but not for the control group. Nonsteroidal anti-inflammatory drug therapy plus kinesiology tape reduced pain and improved functional status, as well as decreasing the common extensor tendon thickness and radial nerve cross-sectional area.[118]

II Tezel et al[182] completed a randomized placebo-controlled trial to evaluate short-term effects of kinesiology tape on pain, function, grip strength, and wrist extensor strength in LET. This study included 48 patients who were randomly allocated to either the treatment group (n = 27) or the control group (n = 21). The VAS, PRTEE, grip strength, and wrist extensor strength measured by an isokinetic device were recorded before and after the treatment. Kinesiology tape was applied for a 5-day duration, and it was repeated 3 times. No significant differences in improvement of pain and function between the kinesiology tape or control groups were noted.[182]

Evidence Synthesis

Diamond-deloading taping technique with rigid tape at the lateral epicondyle appears to have an immediate positive effect on PFGS over sham taping and control groups. A recent meta-analysis demonstrated a positive effect of generic kinesiology tape over control conditions. Generic kinesiology tape plus physical therapy had a positive effect on pain and function when compared to sham tape plus physical therapy, to physical therapy alone, or to physical therapy plus ESWT. However, a similar kinesiology tape technique alone was no better in improving outcomes compared with sham taping alone. Therefore, generic kinesiology tape appears to be more effective when used as part of a multimodal treatment program compared to being used on its own.

Several studies only reported on the immediate effects of tape application, which supports the immediate effectiveness of the tape on pain and grip strength. However, there is conflicting evidence on the medium and long-term effectiveness of the therapeutic tape. The application of tape ranged from 1-time application to 2-3 times over 2 weeks; the mean duration of symptoms of individuals included in studies ranged from approximately 5 weeks to 14 months. No serious adverse effects were reported; the most common minor adverse effect was mild skin irritation with the use of tape.

Individuals who have LET symptoms with high irritability may benefit from either rigid or kinesiology taping techniques to improve pain and function, as long it controls their symptoms and does not cause skin irritation.

Gaps in Knowledge

Current evidence examines the immediate and short-term effects of either rigid tape or kinesiology taping application; additional information is needed on the midterm and long-term effects of any type of taping. The application of therapeutic taping may be enhanced by exercise in the long term, but more evidence is needed. Not enough information is available to make a definitive recommendation regarding types of taping strategies or optimal dosages. While no studies suggested a harmful effect of taping, skin irritation is a risk.

RECOMMENDATION

B Clinicians should use rigid taping techniques for immediate/short-term pain relief and improvement in pain-free muscle function in those with irritable LET.

C Clinicians should use kinesiology tape application as a part of a multimodal treatment program for immediate and short-term management of pain and muscle function in individuals with LET.

CRYOTHERAPY

The use of cryotherapy and heat has been anecdotally recommended as an intervention for years; however, very few controlled trials have investigated their use. Cold is traditionally used to mediate pain and the inflammatory process. Theoretically, heat modalities may be used to increase soft tissue extensibility to facilitate stretching and increase local blood flow to enhance healing. No research of acceptable quality was found related to the effectiveness of hot packs for symptoms of LET.

II Macedo et al[116] randomized 112 female volunteers into 1 of 7 groups including a control (rest), ice application alone (700-g crushed ice pack on the lateral region of the elbow), and conventional and burst TENS groups with and without ice application to the lateral elbow. Pressure pain threshold was measured immediately before and after treatment application. In the immediate short term, those groups who received cryotherapy alone, burst TENS alone, and a combination of the 2 improved significantly. The burst TENS + cryotherapy group showed significantly superior pain tolerances (MD, 4.9; 95% CI: 4.8, 5.0) compared with all other groups.[116]

III Agostinucci et al[1] reported a blinded controlled study in which 71 individuals with symptoms of LET greater than 3 months were randomized into 1 of 4

home program treatment groups: exercise only, gel cold pack plus exercise, an extended-release cold pack plus exercise, and an extended-release cold pack only. Each treatment regimen was performed twice a day, at least 4 days a week, for 6 weeks. All 4 treatment groups demonstrated similar improvements in pain, grip strength, and function as measured by the DASH; however, no significant differences in improvement were observed between groups ($P>.05$).[1] Without a control group as a comparison, we are unable to determine effectiveness of the different interventions included in this study.

Evidence Synthesis

Burst TENS + cryotherapy to the lateral elbow appears to improve immediate pain thresholds compared with no treatment and the application of either modality alone in participants with greater than 3 months symptom duration. The use of gel and extended-release cold packs with or without exercise demonstrated similar improvement in outcomes when compared to exercise alone. There is no evidence to suggest that the use of cryotherapy has any adverse effect when used with patients who have LET. Moreover, no evidence that examined the effect of cryotherapy on individuals with irritable symptoms of LET was located. Given the known effects on the inflammatory process, the use of cryotherapy in irritable symptoms may be more impactful.

Gaps in Knowledge

No evidence examining the use of heat for the treatment of LET was located. No evidence examining the effects of cryotherapy on pain and function, specifically in individuals with irritable symptoms, was located. There were no trials examining the effects of ice massage. High-quality clinical trials that include a control group or placebo group to compare with cryotherapy interventions are needed to fully elucidate the benefit of ice. Additionally, identifying subgroups of patients with LET who would most likely benefit from cryotherapy, based on behavior of symptoms, is needed.

RECOMMENDATION

C Clinicians may use cryotherapy combined with burst TENS to reduce pain in the short term in individuals with symptoms of LET for greater than 30 days.

E Clinicians may use cryotherapy to reduce pain in individuals with irritable symptoms of LET.

THERAPEUTIC ULTRASOUND

II When looking at US as a stand-alone treatment, a 2005 meta-analysis of 4 studies found that the pooled effect for global improvement was not statistically different between groups (RR, 1.01; 95% CI: 0.62, 1.65) at 3-month follow-up.[17] Later systematic reviews found limited evidence that US was more effective in providing pain relief and improving pain-free function than chiropractic care and exercise in the short term (6 weeks)[82] and that US was more effective at reducing pain than a placebo treatment at 13 weeks (SMD, −0.98; 95% CI: −1.64, −0.33).[50] In a more recent study, 51 subjects with LET symptoms for less than 6 months were randomized into 3 groups: continuous US (1.5 MHz, 1 W/cm^2, 5-cm applicator), pulsed US (1:4), and sham US.[85] All participants received 10 treatments once per day for over 2 weeks. Although no differences between groups was seen at 2 weeks ($P<.05$), both continuous and pulsed US groups demonstrated greater improvements in pain (VAS) and function (PRTEE) compared with the sham US group ($P<.05$) at 6-week follow-up.[85] Mean differences and effect sizes were not reported.

II Studies comparing US to ESWT have had conflicting results. A clinical trial[109] compared the analgesic effects of ESWT to those receiving US therapy (1 MHz, 0.8 W/cm^2 for <10 minutes) in patients with chronic LET (>12 months duration of symptoms). Patients were randomized to receive ESWT (5 treatments, once per week) or therapeutic US (10 treatments, 3 times a week). There was a significantly greater reduction in pain in the group receiving ESWT (88% reporting good or excellent pain reduction) compared to the US group (28% reporting good or excellent pain reduction) immediately posttreatment.[109] However, results differed in later studies. Yalvac et al[206] compared ESWT and therapeutic US (1.5 MHz, 1 W/cm^2 for 5 minutes) once per day for 10 days for the treatment of LET. A total of 44 patients with chronic (>3 months) LET were included. Patients were evaluated before therapy, immediately after therapy, and 1 month after treatment on the PRTEE, Short Form-36 (SF-36), VAS for pain, grip strength, and QuickDASH. Both ESWT and therapeutic US were equally effective in treating LET in the short term especially with improving VAS pain scores (MDs > 22/100 for both treatments) and QuickDASH scores (MDs > 15/100 for both treatments).[206] However, no differences in improvement in any of the outcomes were demonstrated in either group; the benefits over a placebo or control group were not evaluated. In a similar study, Özmen et al[139] also found that US was not superior to either ESWT in reducing symptoms of pain (P = .112), function (P = .450), or grip strength (P = .956) in patients with LET.

Evidence Synthesis

There is conflicting evidence for US as a stand-alone treatment in decreasing pain and improving function. When compared to ESWT, US does not appear to have better outcomes. However, as identified in earlier sections, exercise and mobilization sections were more effective than US as a stand-alone

treatment. It should be noted that a variety of parameters were used in studies with 1, 1.5, or 3 MHz frequency; 0.5 to 1 W/cm^2 intensities; 3 to 5 cm^2 applicators; continuous or pulsed US (1:4); and treatment times between 5 and 10 minutes applied directly over the lateral epicondyle. Ultrasound was most commonly administered for 10 treatments ranging from daily to 3 times a week. While there does not seem to be a benefit for US as a stand-alone treatment over exercise and mobilization, no studies suggested a harmful effect from US.

Gaps in Knowledge

US parameters differed among studies making comparisons difficult. High-quality controlled studies on the effects of both thermal and pulsed US in individuals with LET are needed. Examination of the optimal parameters including US wave frequency, magnitude of application time, and clear delineation of treatment area is needed in this patient population. Studies should include control or placebo groups and should identify subgroups of patients with LET who would most likely benefit from US, based on acuity, and behavior of symptoms. Study designs to determine whether US is most effective when performed in isolation or as an adjunct to other treatments are also needed.

RECOMMENDATION

D Based on conflicting evidence, a recommendation cannot be made for the use of US as a stand-alone treatment.

PHONOPHORESIS

II Baktir et al[7] in 2018 conducted an RCT to compare the effectiveness of low-intensity laser therapy (LILT), phonophoresis, and iontophoresis. Fifteen participants were randomized to each group; however, 3 participants each in the LILT and phonophoresis groups and 2 participants in the iontophoresis group discontinued treatment for unreported reasons. The LILT group received laser applied with a wavelength of 904 nm, 50 Hz, and a maximum peak power of 0.12 mW to the lateral epicondyle, and 4 painful points surrounding it for an unknown amount of time; the phonophoresis group received prednisolone (2 mg/d) mixed with water-based US gel applied with a 5-cm^2 applicator at 1 W/cm^2 and 1 MHz for 7 minutes to the lateral epicondyle; and the iontophoresis group received direct current electrical stimulation using 5 mL of 0.4% prednisolone to the active negative electrode placed over the lateral epicondyle for 40 mA min. All participants received treatment 5 times a week for 3 weeks. The pain VAS, PPT algometer, the PRTEE, and grip strength dynamometer were used to measure outcomes at baseline and at the end of 15 sessions. Within-group mean change in scores were reported for each outcome. Although all groups improved, there were no significant differences between group improvements in pain at rest (P = .07), PPT (P = .89), grip strength in elbow extension (P = .06), or function (P = .97).[7] No control group was used as a comparison; therefore, improvements could have been a result of natural history. Although, symptom acuity and severity were not described, participants reported average symptom duration of between 44 and 48 weeks and were presumably not in an inflammatory state. The administration of anti-inflammatory medications delivered through both phonophoresis and iontophoresis may not have been as effective as if they were administered in the early inflammatory stages of LET.

II Nagrale et al[128] compared 2 groups (n = 60) with LET with a duration of symptoms of 1 month or more, who were randomly assigned to receive either 10 minutes of deep transverse friction massage plus a single application of Mill's manipulation for each session or phonophoresis using a 1% diclofenac sodium gel plus supervised exercise. Phonophoresis was applied using continuous mode, 1 MHz, at 0.8 W/cm^2 over the area of the lateral epicondyle for 5 minutes. The supervised exercise program consisted of static stretching followed by eccentric strengthening of the wrist extensors. Both groups demonstrated improvement in pain, PFGS, and function as measured by the PTREE at 4 and 8 weeks. However, the group receiving transverse friction massage and manipulation demonstrated significantly better scores on all measures (P<.05) than the group receiving phonophoresis plus supervised exercise at all follow-up periods except day 1. The calculated effect size of this group at the 8-week follow-up was 0.74 for PFGS, −0.74 for function, and −0.81 for VAS.[128] The average symptom duration in the group receiving manipulation was 14.5 and 12.5 weeks in the phonophoresis group. It may have been more appropriate for the investigators to select a subgroup of individuals with a more acute, inflammatory phase of LET to assess the effectiveness of the anti-inflammatory medication administration through phonophoresis.

II The low-quality evidence presented in the systematic review by Bisset et al[16] indicates that there does not appear to be a positive effect of phonophoresis when compared to US in individuals with LET. There was no significant difference between groups in global improvement (RR, 2.7; 95% CI: 0.34, 21.53), pain (SMD, 0.25; 95% CI: −0.66, 1.15), or in PFGS (SMD, 0.32; 95% CI: −0.59, 1.23) in the short term (5 weeks) when US was compared to phonophoresis using a hydrocortisone coupling gel in individuals with LET.[17,178] A second study[70] reported no statistically significant difference in pain (McGill Pain Questionnaire) between a home exercise program and each of the following conditions: US, phonophoresis (10% hydrocortisone), TENS, or injection (reported as not significant; P value not reported). However, all groups were reported to have improved

significantly from baseline to the last day of treatment (day 5). Evidence in this systematic review does not support the use of phonophoresis for short-term relief of symptoms due to LET.

Evidence Synthesis

A preponderance of level 2 studies, including 1 systematic review and 2 RCTs, demonstrate no benefit of phonophoresis application (with 10% hydrocortisone gel, topical prednisolone [2 mg/d], or 1% diclofenac sodium gel) over US alone, TENS, LILT, iontophoresis, cortisone injection, or friction massage plus Mill's manipulation to the elbow. Weak evidence suggests that other interventions, such as massage and manipulation, may be more effective than phonophoresis in the management of LET. Studies examining the effects of anti-inflammatory medications delivered through phonophoresis have not consistently targeted subgroups of individuals with acute or highly irritable symptoms who may benefit from the delivery of these medications. No adverse effects or complications were reported in any of the studies.

Gaps in Knowledge

Evidence, to this point, is not favorable for the use of phonophoresis to administer anti-inflammatory medications to manage pain and function in LET. Few studies selected individuals who may be more likely to benefit from the administration of anti-inflammatory medications based on acuity and irritability of symptoms. It is also possible that alternative medications administered through the mechanism of phonophoresis could be effective, but no high-quality evidence exists to support this assertion. Because the parameters of the US used to drive the medications into the tissues varied or were not clearly delineated in studies, the optimal frequency, intensity, duty cycle, and optimal treatment area are not known for phonophoresis in the management of LET.

RECOMMENDATION

C Clinicians should not use phonophoresis with 10% hydrocortisone gel, topical prednisolone (2 mg/d), or 1% diclofenac sodium gel for the treatment of LET.

IONTOPHORESIS

II Da Luz[41] et al conducted a double-blind RCT with 24 adults with LET, of unknown symptom duration or irritability, assigned to either an iontophoresis group (with 4 mg/mL dexamethasone and 4% lidocaine gel) using 5 mA for 15 minutes or a galvanic electrical current group. Both groups received treatment 3 times a week for 4 weeks while single-session treatment duration was 15-20 minutes. At final measurements, the iontophoresis group demonstrated significantly lower pain at rest than the galvanic current group (P = .002). The mean (±SD) pain level in the galvanic current group reduced from 3.50 ± 2.11 to 2.50 ± 1.57 (P = .032) and the iontophoresis group demonstrated pain reduction from 3.83 ± 1.80 to 0.58 ± 0.99 (P<.001). Pain with exertion and PTREE scores were also less in the iontophoresis group compared with the galvanic current group (P<.001). No significant differences in grip strength were seen between groups.[41] The authors did not mention adverse effects of either modality.

II As part of the RCT by Baktir et al[7] described in the section on phonophoresis, evidence supports the efficacy of iontophoresis delivered with prednisolone-saline solution (5 mL of 0.4% prednisolone), after approximately 15 treatment sessions over 3 weeks of iontophoresis as a stand-alone modality in patients with an average duration of symptoms equal to 12 months. Along with improvements in pain (ES = 1.22), improvements in function and grip strength were also associated with the iontophoresis group (PRTEE: P = .006, ES = 0.78; grip strength with elbow extension, P = .011, ES = 1.03; grip strength with elbow flexion, P = .003, ES = 0.52).[7] Of the 3 modalities (iontophoresis [3-5 mA at 40 mA/min], laser [.12 mW], and phonophoresis [topical prednisolone, 2 mg/d at 1 W/cm^2 and 1 MHz]), iontophoresis was the only modality shown to be beneficial for improving pain and function on the PRTEE. Therefore, when both pain and function are significant impairments related to LET, iontophoresis may be a good modality choice in the short term. No notation of adverse effects for any of the modalities was made.

II Sims et al[172] conducted a large-scale systematic review of level 1 or 2 RCTs assessing nonsurgical interventions in the management of LET. Specifically, for iontophoresis, 4 RCTs were located and assessed. In general, regardless of the drug, iontophoresis provided a significant improvement (P<.05) in self-reported pain in the short term when compared to a placebo; however, pain scores were not significantly different at moderate- to long-term follow-ups. No pooling of data was conducted. No moderate or severe adverse effects were reported.[172]

II Bisset et al[16] evaluated 4 systematic reviews that compared the effects of iontophoresis with a placebo or other interventions. The RCTs included in all the reviews were of very low quality according to the GRADE evaluation of evidence. Iontophoresis coupled with an active anti-inflammatory drug may be effective for 2 weeks but not at 4 weeks for reducing pain. It was unclear whether iontophoresis improved a patient's self-reported global improvement.[16] As part of this review, Bisset also included a previous systematic review performed in 2005.[17] Three studies examined the effect of iontophoresis on symptoms of LET in their meta-analysis. Pooled data on self-rated global improvement

demonstrated no significant differences between groups receiving a corticosteroid solution administered by iontophoresis when compared to those receiving a placebo in the short term (1-3 months) (RR, 1.09; 95% CI: 0.77, 1.53) or in the long term (6-12 months) (RR, 1.52; 95% CI: 0.97, 2.38). One study examined the effect of a nonsteroidal anti-inflammatory medication (pirprofen) delivered by iontophoresis at both high and low doses compared to saline or sham iontophoresis. The iontophoresis groups demonstrated significant improvements in pain (VAS) and function (a functional impairment rating scale) in the short term.[17]

II In a systematic review by Kohia et al,[98] 2 of the 12 articles examined the effectiveness of iontophoresis. The first compared naproxen iontophoresis to naproxen phonophoresis with both groups receiving a standard physical therapy program after application of the modality. The other study compared sodium diclofenac and sodium salicylate iontophoresis with both groups receiving infrared treatment (no data provided). Weak evidence (no data provided) supported the use of sodium diclofenac over sodium salicylate iontophoresis for reducing symptoms of LET in the short term (less than 6 months). Naproxen iontophoresis and phonophoresis both resulted in similar improvements in grip strength and pain.[98] This systematic review was not included in the review by Bisset et al.[16]

Evidence Synthesis

Weak evidence demonstrates a benefit of using iontophoresis for delivery of an anti-inflammatory medication (naproxen, sodium diclofenac, pirprofen, prednisolone) over placebo or phonophoresis in the short term (<2 weeks) for managing pain and improving function in patients with LET. Although symptom duration of individual studies is not consistently defined, iontophoresis appears to be beneficial in patients presenting with acute or highly irritable symptoms of LET. There appears to be no long-term benefit of iontophoresis. Although minor skin irritations may occur with the use of iontophoresis, no study reported any moderate or severe adverse or harmful events.

Gaps in Knowledge

It is not clear as to the optimal dosage or type of anti-inflammatory medication it takes to improve outcomes in patients with LET when using iontophoresis. Care should be taken to include only participants in the inflammatory phase of LET as they most likely benefit from the administration of anti-inflammatory medication.

RECOMMENDATION

C Clinicians may use iontophoresis with an anti-inflammatory drug, early in the rehabilitation phase (no later than 2-4 weeks from onset or aggravation of symptoms), in individuals presenting with highly irritable symptoms of LET.

TENS

II Macedo et al[116] randomized 112 female volunteers, with mean age of 22 years, into 1 of 7 groups for a 1-time intervention: (1) control (rest for 25 minutes), (2) placebo TENS (TENS unit turned on, but with zero amplitude), (3) conventional TENS (symmetrical biphasic pulsed current, with frequency of 100 Hz, pulse duration of 100 μs, and sensory-level amplitude), (4) burst TENS (carrier frequency of 100 Hz burst modulated at 4 Hz, pulse duration of 200 μs, and motor-level amplitude), (5) cryotherapy (700-g crushed ice pack on the lateral region of the elbow), (6) cryotherapy in combination with burst TENS, and (7) cryotherapy in combination with conventional TENS. A pressure algometer was used to obtain the pain threshold and tolerance of each volunteer during initial (pre) and final (post)assessments. Immediate results indicated that the groups receiving burst TENS alone (pain tolerance; MD, 3.8; 95% CI: 3.7, 3.9), cryotherapy alone (pain tolerance; MD, 1.9; 95% CI: 1.8, 2.0), and burst TENS in combination with cryotherapy (pain tolerance; MD, 4.9; 95% CI: 4.8, 5.0) improved significantly with pain thresholds and tolerance. In addition, burst TENS + cryotherapy produced significantly (P<.001) superior pain tolerances across all other groups.[116]

II Dingemanse et al[50] in their systematic review of electrophysical modalities for the treatment of LET found one low-quality study[202] that demonstrated a positive effect of either high-frequency (5 KHz modulated by 100 Hz) or low-frequency (5 KHz modulated by 2 Hz) TENS when applied to acupuncture points over placebo TENS. No statistical difference in the percentage changes of VAS scores between the low- and high-frequency TENS groups was seen; however, a significant difference was demonstrated between both TENS groups and the sham TENS groups (P<.05). These effects were demonstrated over 2 weeks.[50]

II Chesterton et al[30] conducted an RCT that included 241 adults who were randomized into groups receiving primary care management plus TENS or a group receiving primary care management alone. Primary care management consisted of instruction in activity modification, self-management, and exercises. The results demonstrated no additional benefit of using continuous high-frequency TENS with a biphasic waveform applied for 45 minutes once a day for 6 weeks as an adjunct treatment to a consultation with a general practitioner for education and advice on exercises in patients newly diagnosed with LET. Forty-three percent of all participants reported symptom duration exceeding 3 months.

At final examination (6 weeks), the between-group MD in pain was −0.33 (95% CI: −0.96, 0.31).[30]

Evidence Synthesis

One level 2 study supports the use of burst-modulated TENS using a frequency of 100 Hz, burst modulated at 4 Hz, pulse duration of 200 μs, and motor-level amplitude for 25 minutes, with or without cryotherapy, to manage pain over no treatment, cryotherapy alone, or conventional TENS alone or applied with an ice pack for immediate pain relief in individuals with LET. Weak evidence supports the use of high- or low-frequency TENS applied to acupuncture points for pain relief over placebo TENS for 20 minutes, 3 times a week for 2 weeks. One level 2 study demonstrates no difference between high-frequency TENS application plus education and exercise instruction, and education and exercise instruction alone. As with any electrical modality, contraindications and precautions should be considered before the application of TENS. No consistent description of which individuals with LET may benefit most from the addition of TENS to treatment was found. No study reported any adverse responses to the application of TENS.

Gaps in Knowledge

High-quality clinical trials are needed to further substantiate the benefit of TENS for short-term, midterm, and long-term pain relief in patients with symptoms of LET. It is unclear as to which subgroups of patients with LET based on behavior of symptoms would best benefit from the use of TENS for pain control. The effect of specific parameters and differences in placement of TENS electrodes on pain has not been clearly established.

RECOMMENDATION

C Clinicians may use burst TENS applied to the painful region or high- or low-frequency TENS applied to acupuncture points, for short-term pain relief in individuals with LET.

LASER

I Kaydok et al[94] randomized 60 patients with symptoms greater than 4 weeks into 2 groups to compare the short-term effectiveness of HILT (1064 nm; Phase I: 3 sessions 6 J/cm2 and Phase II: 6 sessions 120-150 J/cm2) and LILT (904 nm, 2.4 J/cm2). Along with laser treatments being applied 3 times a week for 3 weeks, both groups received a lateral counterforce brace. While both groups showed significant improvements in VAS, QuickDASH, SF-36, and handgrip strength measured at 3 weeks (P<.001), the HILT had better handgrip strength (27.3 vs 22.5 kg, P = .018), QuickDASH scores (24.2 vs 30.1 kg, P = .046), and SF-36 (physical component) scores (63.3 vs 59.4 kg, P = .014) at 3 weeks.

II A recent systematic review and meta-analysis by Lian et al[108] pooled data from 6 randomized placebo-controlled trials that included some form of laser therapy (high intensity, low intensity, Ga-As, He-Ne). When assessing grip strength, there was no significant difference (SMD, 0.284; 95% CI: −0.147, 0.714) in follow-up periods ≤4 weeks. However, there was significant improvement in grip strength (SMD, 0.576; 95% CI: 0.286, 0.866) when looking at follow-up periods 5-26 weeks. Laser therapy was also found to demonstrate significant analgesic effects (SMD, 1.313; 95% CI: 0.514, 2.111) between 5 and 26 weeks.[108]

II Baktir et al[7] compared LILT (904 nm), phonophoresis (1 W/cm^2, 1 MHz with 2 mg/d prednisolone), and iontophoresis (0.4% prednisolone 40 mA/min) in an RCT with 37 subjects with pain for at least 1 month. After 15 treatment sessions (5 times a week for 3 weeks) the LLIT and iontophoresis groups were found to have a significant reduction in pain VAS (P = .016-0.008; ES, 0.58-1.49) and PRTEE (P = .04-0.0006; ES, 0.78-0.92) scores. However, the differences between the 3 groups were not significant (P = .07-.97). All subjects were treated 5 times a week for 3 weeks.

Six earlier systematic reviews have also assessed the effectiveness of LILT on LET.[17,19,27,50,172,185] refvariety of parameters were noted,[17,19,50,172,185] Bisset et al[19] and Tumilty et al[185] identified that a 904-nm wavelength applied directly over the common extensor tendon may have a positive effect on short-term pain and functional outcomes that may not last beyond 6 weeks. Chang et al[27] found that when looking at pain reduction with LILT applied to tender points or myofascial trigger points, there was an immediate effect (pooled ES, −0.71; 95% CI: −0.82,~−0.60), as well as at follow-up time between 3 and 8 weeks (pooled ES, −1.05; 95% CI: −1.16,~−0.94). Low-intensity laser therapy application was also able to increase the grip force (pooled ES, 1.09; 95% CI: 0.91, 1.27) and ROM (pooled ES, 0.72; 95% CI: 0.50,0.94) at follow-up ranging between 4 to 8 weeks.

Evidence Synthesis

Five of six systematic reviews/meta-analyses from 2005 to 2014 report conflicting results and significant heterogeneity of LILT parameters in studies examining its effect on outcomes in patients with LET greater than 4 weeks symptom duration. Recommended parameters for laser included LILT with 904-nm wavelength directly over the common extensor tendon or most painful area of the lateral epicondyle for 9 treatment sessions applied over a period of 2 to 3 consecutive weeks. More recent studies have looked at 3-week outcomes to find LILT, phonophoresis, and iontophoresis not being significantly different and HILT being more effective than LILT.

A 2019 meta-analysis showed, in 6 randomized placebo-controlled studies of adequate quality, a moderate positive effect of LILT on pain and grip strength in follow-up times 5 weeks to 6 months. Most studies gave no information on adverse effects; the studies that did reported no adverse events occurred.

Gaps in Knowledge

More high-quality placebo-controlled trials are needed to elucidate the effect of LILT; additionally, it is possible that specific subgroups of patients with symptoms of LET would benefit from the treatment based on behavior of symptoms. Considerable heterogeneity continues to exist in the parameters used to deliver LILT, and therefore, studies to determine optimal LILT parameters for mitigating symptoms of LET are needed. More research is needed to directly compare HILT to LILT and a placebo or control condition on outcomes in patients with LET.

RECOMMENDATION

C

Clinicians may use laser therapy for improvements in pain and grip strength, seen in follow-up periods >4 weeks to 6 months, for individuals with LET.

ERGONOMICS

Ergonomic training, forearm supports, ergonomic keyboard/mouse, and frequent breaks all positively affect symptoms in the UE of computer users in individuals with cumulative trauma disorders.[64] However, few studies examining workplace interventions focus on individuals specifically with LET. Activity modifications to diminish stress on the wrist extensors are an important aspect of rehabilitation. Modifiable risk factors including repetitive motions of the elbow, forearm, wrist, and hand that aggravate symptoms should be minimized, as should lifting objects with the forearm rotated in a pronated position.

II

Tran et al[184] examined the impact of the addition of a workplace-based education intervention to a standardized hand therapy intervention in workers with either acute or chronic unilateral LET. Forty-nine workers were randomized into a control group of standardized hand therapy alone (n = 25) or into the experimental group who also received the workplace education (n = 24). Six individuals in the experimental group did not receive the treatment as allocated. Both groups demonstrated improvements in pain (NPRS), PFGS, and in function (PRTEE and PSFS); however, no statistically significant differences were detected between groups pain-free grip ES = −.087 and PRTEE combined ES = .182 (P<.05). The study was likely underpowered.

II

Dick et al[49] conducted a systematic review of studies examining the use of workplace interventions for a variety of disorders of the UE. Three articles[28,46,67] pertained to LET; however, due to the lack of high-quality evidence on workplace management of LET, no recommendations specific to LET were made.

Evidence Synthesis

The addition of a workplace-based educational intervention to standard hand therapy intervention did not result in improved outcomes over standard hand therapy alone in workers with work-related LET. Ergonomic interventions including education, behavioral modification, ergonomic equipment, and workstation adjustments to improve postural and UE alignment were not sufficient to reduce symptoms in an administrative assistant with LET, in the absence of other interventions. Very little evidence pertains specifically to LET in the literature relating to the effects of ergonomic interventions.

In research related to individuals with various musculoskeletal disorders of the UE in general,[55,64,96,191] weak evidence supports the use of computer-prompted work breaks, ergonomic training, forearm supports, ergonomic keyboard/mouse, and frequent breaks from typing for improving UE symptoms. While ergonomic interventions have the potential to reduce stresses imparted on the common extensor tendon in those with LET, no harms were noted for ergonomic interventions.

Gaps in Knowledge

High-quality studies are needed to determine the effectiveness of education, behavioral modifications, ergonomic adjustments, and ergonomic equipment, such as nonstandardized or alternative keyboards and computer mice in individuals with LET whose symptoms are suspected to be associated with workplace overuse.

RECOMMENDATION

E

Clinicians may use ergonomic interventions in the management of symptoms in individuals with LET; the implementation of education, behavioral modification, ergonomic equipment, and workstation adjustments is moderately supported by best practice/standard of care.

Interventions Conclusions

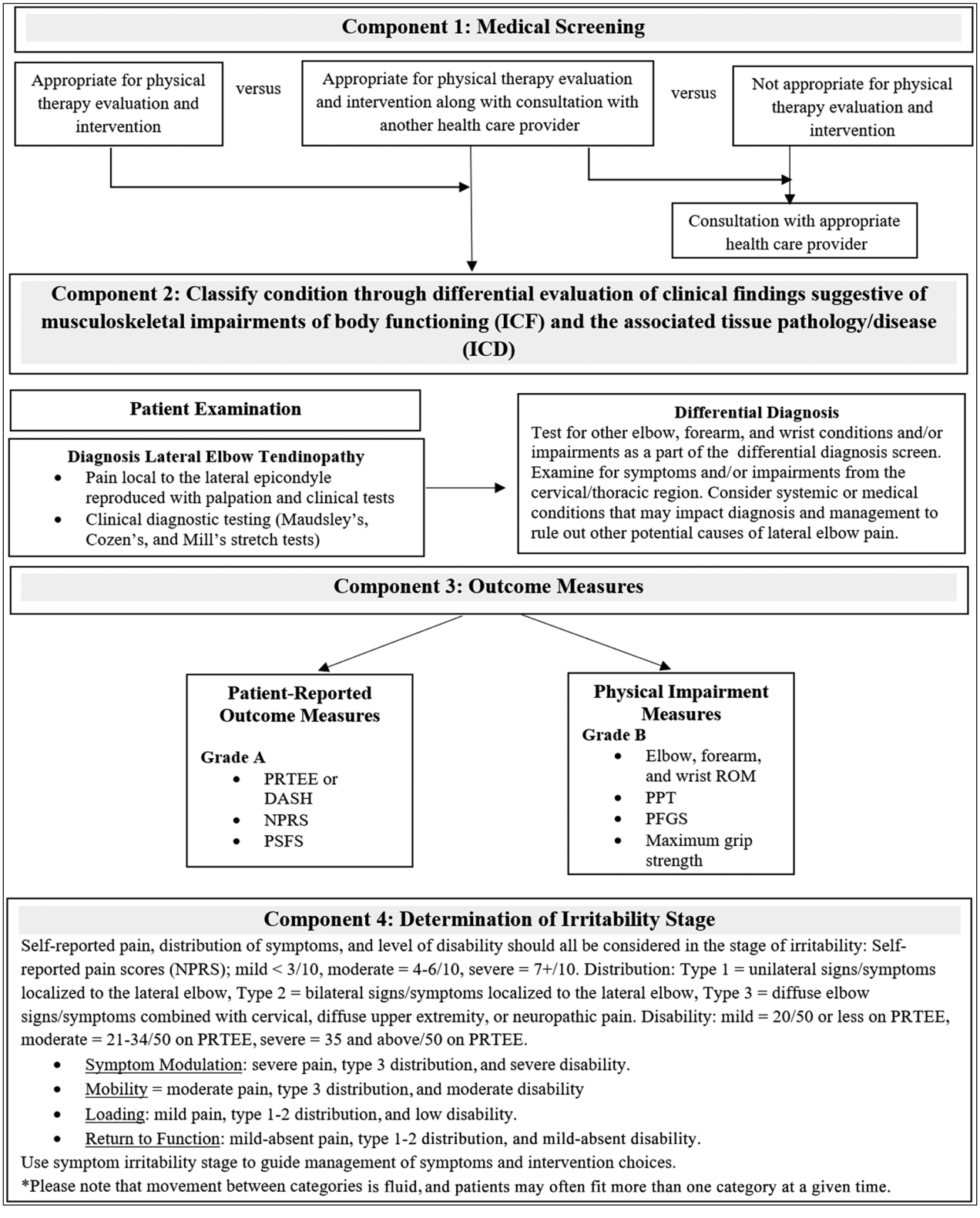
Despite multiple RCTs, systematic reviews, and meta-analyses, investigating physical therapist management of LET, there is not one intervention that stands out as superior to others. The need for multiple interventions seems to reflect the multifactorial etiology of the condition. Moreover, most studies designate broad inclusion criteria, resulting in heterogeneous samples. Few attempts are made to utilize subgroups of patients (eg, based on acuity, distribution, severity, and irritability of symptoms) who are most likely to benefit from any given intervention. This may also contribute to the lack of conclusive evidence on optimal treatment approaches for individuals with LET.

Individuals who present with symptoms that are unpredictable, are easily irritated with activity, are severe in terms of intensity, and/or are deemed by the clinician to be either acute in nature or are an acute exacerbation of persistent/chronic LET should be monitored closely for their response to treatment. Management with physical agents that target inflammation (eg, cryotherapy or iontophoresis to administer anti-inflammatory medications) and/or interventions that mitigate pain (eg, manual therapy techniques, orthoses, taping, electrophysical agents) may be beneficial to stabilize symptoms in the early phase (first 1-2 weeks) of the acute presentation or exacerbation of symptoms. Using physical agents that target the inflammatory process are only appropriate for patients who are exhibiting symptoms that are determined to be acute or inflammatory in nature.

Individuals who present with or who achieve symptoms that are less severe, more predictable, and less irritable (eg, subacute to chronic phases of the condition) are more likely to benefit from progressive initiation of therapeutic exercise including strengthening and a gradual weaning from interventions aimed at reducing pain.

The context in which the individual is required to function (eg, household, work, and/or athletic activities) in addition to the presentation of symptoms should be considered when establishing the plan of care for an individual with LET. Efforts to offload the irritated tissues should be initiated within the context of the individual's environment through education and activity modifications related to modifiable risk factors, particularly biomechanical overloading of the wrist and digit extensors is important throughout the course of care. Gradual reintroduction of tissue loading to optimize tissue health is needed to restore function while minimizing chances of re-irritation of the tendon. Education of the individual on self-care strategies should be provided and emphasized throughout the treatment.

Decision Tree



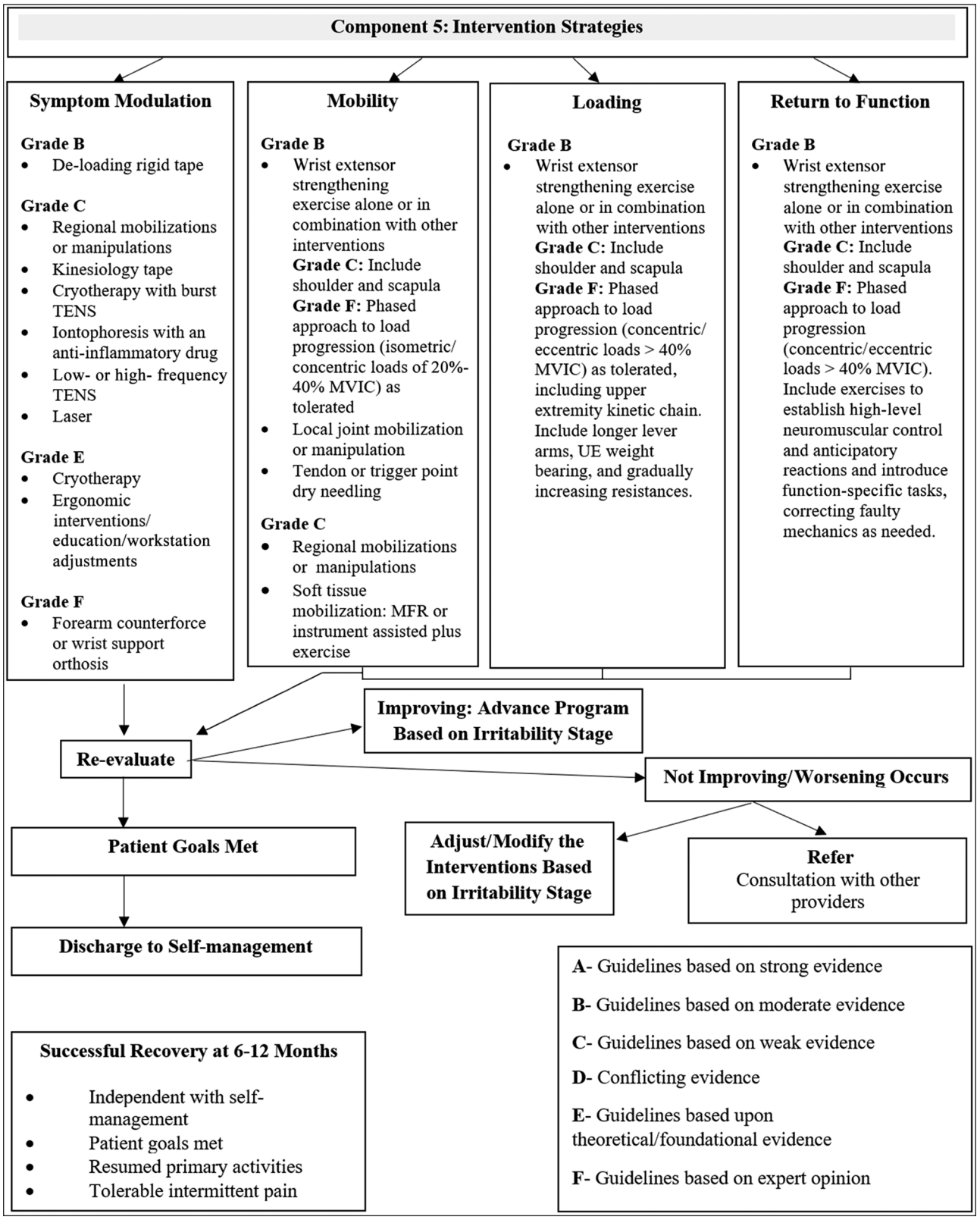
Component 4: Determination of Irritability Stage

Self-reported pain, distribution of symptoms, and level of disability should all be considered in the stage of irritability: Self-reported pain scores (NPRS); mild < 3/10, moderate = 4-6/10, severe = 7+/10. Distribution: Type 1 = unilateral signs/symptoms localized to the lateral elbow, Type 2 = bilateral signs/symptoms localized to the lateral elbow, Type 3 = diffuse elbow signs/symptoms combined with cervical, diffuse upper extremity, or neuropathic pain. Disability: mild = 20/50 or less on PRTEE, moderate = 21-34/50 on PRTEE, severe = 35 and above/50 on PRTEE.

- Symptom Modulation: severe pain, type 3 distribution, and severe disability.
- Mobility = moderate pain, type 3 distribution, and moderate disability
- Loading: mild pain, type 1-2 distribution, and low disability.
- Return to Function: mild-absent pain, type 1-2 distribution, and mild-absent disability.

Use symptom irritability stage to guide management of symptoms and intervention choices.

*Please note that movement between categories is fluid, and patients may often fit more than one category at a given time.



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REFERENCES

1. Agostinucci J, Mclinden J, Cherry E. The effect of cryotherapy and exercise on lateral epicondylitis: a controlled randomised study. *Int J Ther Rehabil*. 2012;19:641-650. https://doi.org/10.12968/ijtr.2012.19.11.641
2. Ajimsha MS, Chithra S, Thulasyammal RP. Effectiveness of myofascial release in the management of lateral epicondylitis in computer professionals. *Arch Phys Med Rehabil*. 2012;93:604-609. https://doi.org/10.1016/j.apmr.2011.10.012
3. Akbar N, Sharif M, Afzal W, Ahmad A, Gilani S, Mohyudin S. Effects of Cyriax manual therapy versus Mulligan technique on pain and grip strength in patients with lateral epicondylitis. *Co-Kinet J*. 2021;8-8. https://doi.org/10.53389/JRCRS.2021090202
4. Alizadehkhaiyat O, Fisher AC, Kemp GJ, Frostick SP. Pain, functional disability, and psychologic status in tennis elbow. *Clin J Pain*. 2007;23:482-489. https://doi.org/10.1097/AJP.0b013e31805f70fa
5. Altan L, Ercan I, Konur S. Reliability and validity of Turkish version of the patient rated tennis elbow evaluation. *Rheumatol Int*. 2010;30:1049-1054. https://doi.org/10.1007/s00296-009-1101-6
6. Armstrong AD, MacDermid JC, Chinchalkar S, Stevens RS, King GJ. Reliability of range-of-motion measurement in the elbow and forearm. *J Shoulder Elb Surg*. 1998;7:573-580. https://doi.org/10.1016/S1058-2746(98)90003-9
7. Baktir S, Razak Ozdincler A, Kaya Mutlu E, Bilsel K. The short-term effectiveness of low-level laser, phonophoresis, and iontophoresis in patients with lateral epicondylosis. *J Hand Ther*. 2019;32:417-425. https://doi.org/10.1016/j.jht.2018.01.002
8. Bales CP, Placzek JD, Malone KJ, Vaupel Z, Arnoczky SP. Microvascular supply of the lateral epicondyle and common extensor origin. *J Shoulder Elb Surg*. 2007;16:497-501. https://doi.org/10.1016/j.jse.2006.08.006
9. Bashardoust Tajali S, MacDermid JC, Grewal R, Young C. Reliability and validity of electro-goniometric range of motion measurements in patients with hand and wrist limitations. *Open Orthop J*. 2016;10:190-205. https://doi.org/10.2174/1874325001610010190
10. Bateman M, Evans JP, Vuvan V, et al. Development of a core outcome set for lateral elbow tendinopathy (COS-LET) using best available evidence and an international consensus process. *Br J Sports Med*. 2022;56:657-666. https://doi.org/10.1136/bjsports-2021-105044
11. Beaton DE, Katz JN, Fossel AH, Wright JG, Tarasuk V, Bombardier C. Measuring the whole or the parts? validity, reliability, and responsiveness of the disabilities of the arm, shoulder and hand outcome measure in different regions of the upper extremity. *J Hand Ther*. 2001;14:128-146. https://doi.org/10.1016/S0894-1130(01)80043-0
12. Benjamin M, Toumi H, Ralphs JR, Bydder G, Best TM, Milz S. Where tendons and ligaments meet bone: attachment sites ('entheses') in relation to exercise and/or mechanical load. *J Anat*. 2006;208:471-490. https://doi.org/10.1111/j.1469-7580.2006.00540.x
13. Bhabra G, Wang A, Ebert JR, Edwards P, Zheng M, Zheng MH. Lateral elbow tendinopathy: development of a pathophysiology-based algorithm. *Orthop J Sports Med*. 2016;4. https://doi.org/10.1177/2325967116670635
14. Binder AI, Hazleman BL. Lateral humeral epicondylitis–a study of natural history and the effect of conservative therapy. *Br J Rheumatol*. 1983;22:73-76. https://doi.org/10.1093/rheumatology/22.2.73
15. Bisset L, Carty M, Smith A. Unilateral lateral epicondylalgia shows a pro-nociceptive pain profile: a case-control observational study. *Clin J Pain*. 2018;34:954-959. https://doi.org/10.1097/AJP.0000000000000615
16. Bisset L, Coombes B, Vicenzino B. Tennis elbow. *BMJ Clinical Evid*. 2011;2011:1117.
17. Bisset L, Paungmali A, Vicenzino B, Beller E. A systematic review and meta-analysis of clinical trials on physical interventions for lateral epicondylalgia. *Br J Sports Med*. 2005;39:411-422. https://doi.org/10.1136/bjsm.2004.016170
18. Blanchette M-A, Normand MC. Cross-cultural adaptation of the patient-rated tennis elbow evaluation to Canadian French. *J Hand Ther*. 2010;23:290-300. https://doi.org/10.1016/j.jht.2010.01.003
19. Blanchette M-A, Normand MC. Augmented soft tissue mobilization vs natural history in the treatment of lateral epicondylitis: a pilot study. *J Manip Physiol Ther*. 2011;34:123-130. https://doi.org/10.1016/j.jmpt.2010.12.001
20. Blazina ME, Kerlan RK, Jobe FW, Carter VS, Carlson GJ. Jumper's knee. *Orthop Clin N Am*. 1973;4:665-678. https://doi.org/10.1016/S0030-5898(20)32343-9
21. Borkholder CD, Hill VA, Fess EE. The efficacy of splinting for lateral epicondylitis: a systematic review. *J Hand Ther*. 2004;17:181-199. https://doi.org/10.1197/j.jht.2004.02.007
22. Bot SDM, van der Waal JM, Terwee CB, et al. Incidence and prevalence of complaints of the neck and upper extremity in general practice. *Ann Rheum Dis*. 2005;64:118-123. https://doi.org/10.1136/ard.2003.019349
23. Bunata ER. Anatomic factors related to the cause of tennis elbow. *J Bone Jt Surg (American)*. 2007;89:1955. https://doi.org/10.2106/00004623-200709000-00010
24. Cacchio A, Necozione S, MacDermid JC, et al. Cross-cultural adaptation and measurement properties of the Italian version of the Patient-Rated Tennis Elbow Evaluation (PRTEE) questionnaire. *Phys Ther*. 2012;92:1036-1045. https://doi.org/10.2522/ptj.20110398
25. CEBM. Oxford Centre for Evidence-based Medicine: Levels of Evidence (March 2009). 2009.
26. Cha YK, Kim S-J, Park NH, Kim JY, Kim JH, Park JY. Magnetic resonance imaging of patients with lateral epicondylitis: relationship between pain and severity of imaging features in elbow joints. *Acta Orthop Traumatol Turc*. 2019;53:366-371. https://doi.org/10.1016/j.aott.2019.04.006
27. Chang W-D, Wu J-H, Yang W-J, Jiang J-A. Therapeutic effects of low-level laser on lateral epicondylitis from differential interventions of Chinese-Western medicine: systematic review. *Photomed Laser Surg*. 2010;28:327-336. https://doi.org/10.1089/pho.2009.2558
28. Chatterjee SD. Workplace upper limb disorders: a prospective study with intervention. *Occup Med (Oxford, England)*. 1992;42:129-136. https://doi.org/10.1093/occmed/42.3.129
29. Chen Z, Baker NA. Effectiveness of eccentric strengthening in the treatment of lateral elbow tendinopathy: a systematic review with meta-analysis. *J Hand Ther*. 2021;34:18-28. https://doi.org/10.1016/j.jht.2020.02.002
30. Chesterton LS, Lewis AM, Sim J, et al. Transcutaneous electrical nerve stimulation as adjunct to primary care management for tennis elbow: pragmatic randomised controlled trial (TATE trial). *BMJ (Clin Res Ed)*. 2013;347:f5160. https://doi.org/10.1136/bmj.f5160
31. Chourasia AO, Buhr KA, Rabago DP, et al. Relationships between biomechanics, tendon pathology, and function in individuals with lateral epicondylosis. *J Orthop Sports Phys Ther*. 2013;43:368-378. https://doi.org/10.2519/jospt.2013.4411
32. Chung B, Wiley JP. Validity, responsiveness and reliability of the Patient-Rated Tennis Elbow Evaluation. *Hand Ther*. 2010;15:62-68. https://doi.org/10.1258/ht.2010.010014
33. Cimatti B, Marcolino AM, Barbosa RI, De Cássia Registro Fonseca MA. A study to compare two goniometric methods for measuring active pronation and supination range of motion. *Hand Ther*. 2013;18:57-63. https://doi.org/10.1177/1758998313495151
34. Cleland JA, Whitman JM, Fritz JM. Effectiveness of manual physical therapy to the cervical spine in the management of lateral epicondylalgia: a retrospective analysis. *J Orthop Sports Phys Ther*. 2004;34:713-722. https://doi.org/10.2519/jospt.2004.34.11.713

35. Coombes BK, Bisset L, Brooks P, Khan A, Vicenzino B. Effect of corticosteroid injection, physiotherapy, or both on clinical outcomes in patients with unilateral lateral epicondylalgia: a randomized controlled trial. *JAMA*. 2013;309:461-469. https://doi.org/10.1001/jama.2013.129
36. Coombes BK, Bisset L, Vicenzino B. A new integrative model of lateral epicondylalgia. *Br J Sports Med*. 2009;43:252-258. https://doi.org/10.1136/bjsm.2008.052738
37. Coombes BK, Bisset L, Vicenzino B. Cold hyperalgesia associated with poorer prognosis in lateral epicondylalgia: a 1-year prognostic study of physical and psychological factors. *Clin J Pain*. 2015;31:30-35. https://doi.org/10.1097/AJP.0000000000000078
38. Coombes BK, Connelly L, Bisset L, Vicenzino B. Economic evaluation favours physiotherapy but not corticosteroid injection as a first-line intervention for chronic lateral epicondylalgia: evidence from a randomised clinical trial. *Br J Sports Med*. 2016;50:1400-1405. https://doi.org/10.1136/bjsports-2015-094729
39. Cullinane FL, Boocock MG, Trevelyan FC. Is eccentric exercise an effective treatment for lateral epicondylitis? a systematic review. *Clin Rehabil*. 2014;28:3-19. https://doi.org/10.1177/0269215513491974
40. da Costa JT, Baptista JS, Vaz M. Incidence and prevalence of upper-limb work related musculoskeletal disorders: a systematic review. *Work*. 2015;51:635-644. https://doi.org/10.3233/WOR-152032
41. da Luz DC, de Borba Y, Ravanello EM, Daitx RB, Döhnert MB. Iontophoresis in lateral epicondylitis: a randomized, double-blind clinical trial. *J Shoulder Elb Surg*. 2019;28:1743-1749. https://doi.org/10.1016/j.jse.2019.05.020
42. da Silva Camassuti PA, Marcolino AM, Tamanini G, Barbosa RI, Barbosa AM, de Cássia Registro Fonseca M. Inter-rater, intra-rater and inter-instrument reliability of an electrogoniometer to measure wrist range of motion. *Hand Ther*. 2015;20:3-10. https://doi.org/10.1177/1758998315570681
43. Day JM, Lucado AM, Dale RB, Merriman H, Marker CD, Uhl TL. The effect of scapular muscle strengthening on functional recovery in patients with lateral elbow tendinopathy: a pilot randomized controlled trial. *J Sport Rehabil*. 2021;30:744-753. https://doi.org/10.1123/jsr.2020-0203
44. Day JM, Lucado AM, Uhl TL. A comprehensive rehabilitation program for treating lateral elbow tendinopathy. *Int J Sports Phys Ther*. 2019;14:818-834. https://doi.org/10.26603/ijspt20190818
45. De Smedt T, de Jong A, Van Leemput W, Lieven D, Van Glabbeek F. Lateral epicondylitis in tennis: update on aetiology, biomechanics and treatment. *Br J Sports Med*. 2007;41:816-819. https://doi.org/10.1136/bjsm.2007.036723
46. Derebery VJ, Devenport JN, Giang GM, Fogarty WT. The effects of splinting on outcomes for epicondylitis. *Arch Phys Med Rehabil*. 2005;86:1081-1088. https://doi.org/10.1016/j.apmr.2004.11.029
47. Descatha A, Albo F, Leclerc A, et al. Lateral epicondylitis and physical exposure at work? a review of prospective studies and meta-analysis. *Arthritis Care Res*. 2016;68:1681-1687. https://doi.org/10.1002/acr.22874
48. Descatha A, Dale AM, Jaegers L, Herquelot E, Evanoff B. Self-reported physical exposure association with medial and lateral epicondylitis incidence in a large longitudinal study. *Occup Environ Med*. 2013;70:670-673. https://doi.org/10.1136/oemed-2012-101341
49. Dick FD, Graveling RA, Munro W, Walker-Bone K. Workplace management of upper limb disorders: a systematic review. *Occup Med (Oxf Engl)*. 2011;61:19-25. https://doi.org/10.1093/occmed/kqq174
50. Dingemanse R, Randsdorp M, Koes BW, Huisstede BMA. Evidence for the effectiveness of electrophysical modalities for treatment of medial and lateral epicondylitis: a systematic review. *Br J Sports Med*. 2014;48:957-965. https://doi.org/10.1136/bjsports-2012-091513
51. Dones VC, Grimmer K, Milanese S, Kumar S. The sensitivity of the provocation tests in replicating pain on the lateral elbow area of participants with lateral epicondylalgia. *J Case Rep*. 2014;1:1.
52. Dones VC, Grimmer K, Thoirs K, Suarez CG, Luker J. The diagnostic validity of musculoskeletal ultrasound in lateral epicondylalgia: a systematic review. *BMC Med Imaging*. 2014;14:10. https://doi.org/10.1186/1471-2342-14-10
53. Dundar U, Turkmen U, Toktas H, Ulasli AM, Solak O. Effectiveness of high-intensity laser therapy and splinting in lateral epicondylitis; a prospective, randomized, controlled study. *Lasers Med Sci*. 2015;30:1097-1107. https://doi.org/10.1007/s10103-015-1716-7
54. Ekstrom RA, Holden K. Examination of and intervention for a patient with chronic lateral elbow pain with signs of nerve entrapment. *Phys Ther*. 2002;82:1077-1086. https://doi.org/10.1093/ptj/82.11.1077
55. Esmaeilzadeh S, Ozcan E, Capan N. Effects of ergonomic intervention on work-related upper extremity musculoskeletal disorders among computer workers: a randomized controlled trial. *Int Arch Occup Environ Health*. 2014;87:73-83. https://doi.org/10.1007/s00420-012-0838-5
56. Etminan Z, Razeghi M, Ghafarinejad F. The effect of dry needling of trigger points in forearm's extensor muscles on the grip force, pain and function of athletes with chronic tennis elbow. *J Rehabil Sci Res*. 2019;6:27-33.
57. Farrar JT, Young JP, LaMoreaux L, Werth JL, Poole RM. Clinical importance of changes in chronic pain intensity measured on an 11-point numerical pain rating scale. *Pain*. 2001;94:149-158. https://doi.org/10.1016/S0304-3959(01)00349-9
58. Fenwick SA, Hazleman BL, Riley GP. The vasculature and its role in the damaged and healing tendon. *Arthritis Res*. 2002;4:252-260. https://doi.org/10.1186/ar416
59. Fernández-Carnero J, Cleland JA, Arbizu RLT. Examination of motor and hypoalgesic effects of cervical vs thoracic spine manipulation in patients with lateral epicondylalgia: a clinical trial. *J Manip Physiol Ther*. 2011;34:432-440. https://doi.org/10.1016/j.jmpt.2011.05.019
60. Fernández-Carnero J, Fernández-de-las-Peñas C, Cleland JA. Immediate hypoalgesic and motor effects after a single cervical spine manipulation in subjects with lateral epicondylalgia. *J Manip Physiol Ther*. 2008;31:675-681. https://doi.org/10.1016/j.jmpt.2008.10.005
61. Ferreira-Valente MA, Pais-Ribeiro JL, Jensen MP. Validity of four pain intensity rating scales. *Pain*. 2011;152:2399-2404. https://doi.org/10.1016/j.pain.2011.07.005
62. Fredberg U, Stengaard-Pedersen K. Chronic tendinopathy tissue pathology, pain mechanisms, and etiology with a special focus on inflammation: chronic tendinopathy tissue pathology. *Scand J Med Sci Sports*. 2008;18:3-15. https://doi.org/10.1111/j.1600-0838.2007.00746.x
63. George CE, Heales LJ, Stanton R, Wintour S-A, Kean CO. Sticking to the facts: a systematic review of the effects of therapeutic tape in lateral epicondylalgia. *Phys Ther Sport*. 2019;40:117-127. https://doi.org/10.1016/j.ptsp.2019.08.011
64. Goodman G, Kovach L, Fisher A, Elsesser E, Bobinski D, Hansen J. Effective interventions for cumulative trauma disorders of the upper extremity in computer users: practice models based on systematic review. *Work (Read Mass)*. 2012;42:153-172. https://doi.org/10.3233/WOR-2012-1341
65. Gruchow HW, Pelletier D. An epidemiologic study of tennis elbow. Incidence, recurrence, and effectiveness of prevention strategies. *Am J Sports Med*. 1979;7:234-238. https://doi.org/10.1177/036354657900700405
66. Guyatt GH, Sackett DL, Sinclair JC, Hayward R, Cook DJ, Cook RJ. Users' guides to the medical literature. IX. A method for grading health care recommendations. *JAMA*. 1995;274:1800-1804. https://doi.org/10.1001/jama.1995.03530220066035
67. Haahr JP, Andersen JH. Prognostic factors in lateral epicondylitis: a randomized trial with one-year follow-up in 266 new cases treated with minimal occupational intervention or the usual approach in general practice. *Rheumatology*. 2003;42:1216-1225. https://doi.org/10.1093/rheumatology/keg360

68. Haahr JP, Andersen JH. Physical and psychosocial risk factors for lateral epicondylitis: a population based case-referent study. *Occup Environ Med*. 2003;60:322-329. https://doi.org/10.1136/oem.60.5.322
69. Hagert CG, Lundborg G, Hansen T. Entrapment of the posterior interosseous nerve. *Scand J Plast Reconstr Surg*. 1977;11:205-212. https://doi.org/10.3109/02844317709025519
70. Halle JS, Franklin RJ, Karalfa BL. Comparison of four treatment approaches for lateral epicondylitis of the elbow*. *J Orthop Sports Phys Ther*. 1986;8:62-69. https://doi.org/10.2519/jospt.1986.8.2.62
71. Hayes C, Bencardino J, Appel M, et al. *ACR Appropriateness Criteria® Chronic Elbow Pain*. Reston, VA: American College of Radiology (ACR); 2015.
72. Heales LJ, Hill C, Kean C, Stanton R. Within- and between-session test-retest reliability of pain-free grip strength in individuals with lateral elbow tendinopathy. *J Sci Med Sport*. 2021;24:S79. https://doi.org/10.1016/j.jsams.2021.09.196
73. Heales LJ, McClintock SR, Maynard S, et al. Evaluating the immediate effect of forearm and wrist orthoses on pain and function in individuals with lateral elbow tendinopathy: a systematic review. *Musculoskelet Sci Pract*. 2020;47:102147. https://doi.org/10.1016/j.msksp.2020.102147
74. Healy A, Farmer S, Pandyan A, Chockalingam N. A systematic review of randomised controlled trials assessing effectiveness of prosthetic and orthotic interventions. *PLOS One*. 2018;13:e0192094. https://doi.org/10.1371/journal.pone.0192094
75. Hefford C, Abbott JH, Arnold R, Baxter GD. The patient-specific functional scale: validity, reliability, and responsiveness in patients with upper extremity musculoskeletal problems. *J Orthop Sports Phys Ther*. 2012;42:56-65. https://doi.org/10.2519/jospt.2012.3953
76. Hegmann KT, Thiese MS, Kapellusch J, et al. Association between epicondylitis and cardiovascular risk factors in pooled occupational cohorts. *BMC Musculoskelet Disord*. 2017;18:227. https://doi.org/10.1186/s12891-017-1593-2
77. Herd CR, Meserve BB. A systematic review of the effectiveness of manipulative therapy in treating lateral epicondylalgia. *J Man Manip Ther*. 2008;16:225-237. https://doi.org/10.1179/106698108790818288
78. Herquelot E, Bodin J, Roquelaure Y, et al. Work-related risk factors for lateral epicondylitis and other cause of elbow pain in the working population. *Am J Ind Med*. 2013;56:400-409. https://doi.org/10.1002/ajim.22140
79. Hill CE, Heales LJ, Stanton R, Kean CO. Pain-free grip strength in individuals with lateral elbow tendinopathy: between- and within-session reliability of one versus three trials. *Physiother Theory Pract*. 2022;1-9. https://doi.org/10.1080/09593985.2022.2030445
80. Hjermstad MJ, Fayers PM, Haugen DF, et al. Studies comparing Numerical Rating Scales, Verbal Rating Scales, and Visual Analogue Scales for assessment of pain intensity in adults: a systematic literature review. *J Pain Symptom Manag*. 2011;41:1073-1093. https://doi.org/10.1016/j.jpainsymman.2010.08.016
81. Holmedal Ø, Olaussen M, Mdala I, Natvig B, Lindbæk M. Predictors for outcome in acute lateral epicondylitis. *BMC Musculoskelet Disord*. 2019;20:375. https://doi.org/10.1186/s12891-019-2758-y
82. Hoogvliet P, Randsdorp MS, Dingemanse R, Koes BW, Huisstede BMA. Does effectiveness of exercise therapy and mobilisation techniques offer guidance for the treatment of lateral and medial epicondylitis? A systematic review. *Br J Sports Med*. 2013;47:1112-1119. https://doi.org/10.1136/bjsports-2012-091990
83. Horger MM. The reliability of goniometric measurements of active and passive wrist motions. *Am J Occup Ther*. 1990;44:342-348. https://doi.org/10.5014/ajot.44.4.342
84. Hsu C-Y, Lee K-H, Huang H-C, Chang Z-Y, Chen H-Y, Yang T-H. Manipulation therapy relieved pain more rapidly than acupuncture among lateral epicondylalgia (tennis elbow) patients: a randomized controlled trial with 8-week follow-up. *Evid-Based Complement Altern Med*. 2016;2016:3079247. https://doi.org/10.1155/2016/3079247
85. Hüseyin Ünver H, Bakilan F, Berkan Tasçioglu F, Armagan O, Özgen M. Comparing the efficacy of continuous and pulsed ultrasound therapies in patients with lateral epicondylitis: a double-blind, randomized, placebo-controlled study. *Turk J Phys Med Rehabil*. 2021;67:99-106. https://doi.org/10.5606/tftrd.2021.4789
86. Jafarian F-S, Barati H, Sadeghi-Demneh E. The Patient-Rated Tennis Elbow Evaluation Questionnaire was successfully translated to Persian. *J Hand Ther*. 2021;34:127-130. https://doi.org/10.1016/j.jht.2019.12.005
87. Jeon S, Miller WM, Ye X. A comparison of motor unit control strategies between two different isometric tasks. *Int J Environ Res Public Health*. 2020;17:E2799. https://doi.org/10.3390/ijerph17082799
88. Jomaa G, Kwan C-K, Fu S-C, et al. A systematic review of inflammatory cells and markers in human tendinopathy. *BMC Musculoskelet Disord*. 2020;21:78. https://doi.org/10.1186/s12891-020-3094-y
89. Joshi S, Metgud S, Ebnezer C. Comparing the effects of manipulation of wrist and ultrasound, friction massage and exercises on lateral epicondylitis: a randomized clinical study. *Indian J Physiother Occup Ther Int J*. 2013;7:205. https://doi.org/10.5958/j.0973-5674.7.3.093
90. Kalainov DM, Cohen MS. Posterolateral rotatory instability of the elbow in association with lateral epicondylitis. A report of three cases. *J Bone Jt Surg*. 2005;87:1120-1125. https://doi.org/10.2106/00004623-200505000-00027
91. Karagiannopoulos C, Sitler M, Michlovitz S. Reliability of 2 functional goniometric methods for measuring forearm pronation and supination active range of motion. *J Orthop Sports Phys Ther*. 2003;33:523-531. https://doi.org/10.2519/jospt.2003.33.9.523
92. Karanasios S, Korakakis V, Whiteley R, Vasilogeorgis I, Woodbridge S, Gioftsos G. Exercise interventions in lateral elbow tendinopathy have better outcomes than passive interventions, but the effects are small: a systematic review and meta-analysis of 2123 subjects in 30 trials. *Br J Sports Med*. 2021;55:477-485. https://doi.org/10.1136/bjsports-2020-102525
93. Kaux J-F, Delvaux F, Schaus J, et al. Cross-cultural adaptation and validation of the Patient-Rated Tennis Elbow Evaluation Questionnaire on lateral elbow tendinopathy for French-speaking patients. *J Hand Ther*. 2016;29:496-504. https://doi.org/10.1016/j.jht.2016.06.007
94. Kaydok E, Ordahan B, Solum S, Karahan A. Short-term efficacy comparison of high-intensity and low-intensity laser therapy in the treatment of lateral epicondylitis: a randomized double-blind clinical study. *Arch Rheumatol*. 2020;35:60-67. https://doi.org/10.5606/ArchRheumatol.2020.7347
95. Khuman PR, Trivedi P, Devi S, Sathyavani D, Nambi G, Shah K. Myofascial release technique in chronic lateral epicondylitis: a randomized controlled study. *Int J Health Sci Res*. 2013;3:45-52
96. Kietrys DM, Gerg MJ, Dropkin J, Gold JE. Mobile input device type, texting style and screen size influence upper extremity and trapezius muscle activity, and cervical posture while texting. *Appl Ergon*. 2015;50:98-104. https://doi.org/10.1016/j.apergo.2015.03.003
97. Koh K-H, Lee KW, Cho JH, Park D, Yeom JW, Lee HI. The patient-rated tennis elbow evaluation questionnaire was successfully translated to Korean. *J Hand Ther*. 2021. https://doi.org/10.1016/j.jht.2021.04.007
98. Kohia M, Brackle J, Byrd K, Jennings A, Murray W, Wilfong E. Effectiveness of physical therapy treatments on lateral epicondylitis. *J Sport Rehabil*. 2008;17:119-136. https://doi.org/10.1123/jsr.17.2.119
99. Kraushaar BS, Nirschl RP. Tendinosis of the elbow (tennis elbow). Clinical features and findings of histological, immunohistochemical, and electron microscopy studies. *J Bone Jt Surg*. 1999;81:259-278. https://doi.org/10.2106/00004623-199902000-00014
100. Krey D, Borchers J, McCamey K. Tendon needling for treatment of tendinopathy: a systematic review. *Physician Sportsmed*. 2015;43:80-86. https://doi.org/10.1080/00913847.2015.1004296

101. Laimi K, Mäkilä A, Bärlund E, et al. Effectiveness of myofascial release in treatment of chronic musculoskeletal pain: a systematic review. *Clin Rehabil*. 2018;32:440-450. https://doi.org/10.1177/0269215517732820

102. LaStayo PC, Wheeler DL. Reliability of passive wrist flexion and extension goniometric measurements: a multicenter study. *Phys Ther*. 1994;74:162-174. https://doi.org/10.1093/ptj/74.2.162

103. Lee A, Lee-Robinson A. Evaluating concomitant lateral epicondylitis and cervical radiculopathy: a correlation was found, suggesting comanagement of the disorders. *J Musculoskelet Med*. 2010;27:111-115.

104. Antuna SA, O'Driscoll SW. Snapping plicae associated with radiocapitellar chondromalacia. *Arthrosc: J Arthrosc Relat Surg*. 2001;17:491-495. https://doi.org/10.1053/jars.2001.20096

105. Lee W-H, Kwon O-Y, Yi C-H, Jeon H-S, Ha S-M. Effects of taping on wrist extensor force and joint position reproduction sense of subjects with and without lateral epicondylitis. *J Phys Ther Sci*. 2011;23:629-634. https://doi.org/10.1589/jpts.23.629

106. Leung HB, Yen CH, Tse PYT. Reliability of Hong Kong Chinese version of the Patient-rated Forearm Evaluation Questionnaire for lateral epicondylitis. *Hong Kong Med J*. 2004;10:172-177.

107. Lewis M, Hay EM, Paterson SM, Croft P. Effects of manual work on recovery from lateral epicondylitis. *Scand J Work Environ Health*. 2002;28:109-116. https://doi.org/10.5271/sjweh.654

108. Lian J, Mohamadi A, Chan JJ, et al. Comparative efficacy and safety of nonsurgical treatment options for enthesopathy of the extensor carpi radialis brevis: a systematic review and meta-analysis of randomized placebo-controlled trials. *Am J Sports Med*. 2019;47:3019-3029. https://doi.org/10.1177/0363546518801914

109. Lizis, Pawel. Analgesic effect of extracorporeal shock wave therapy versus ultrasound therapy in chronic tennis elbow. *J Phys Ther Sci*. 2015;27:2563-2567. https://doi.org/10.1589/jpts.27.2563

110. Loew LM, Brosseau L, Tugwell P, et al. Deep transverse friction massage for treating lateral elbow or lateral knee tendinitis. *Cochrane Database Syst Rev*. 2014;CD003528. https://doi.org/10.1002/14651858.CD003528.pub2

111. Lucado AM, Dale RB, Vincent J, Day JM. Do joint mobilizations assist in the recovery of lateral elbow tendinopathy? A systematic review and meta-analysis. *J Hand Ther*. 2019;32:262-276.e261. https://doi.org/10.1016/j.jht.2018.01.010

112. MacDermid, JC. Update: the patient-rated forearm evaluation questionnaire is now the patient-rated tennis elbow evaluation. *J Hand Ther*. 2005;18:407-410. https://doi.org/10.1197/j.jht.2005.07.002

113. MacDermid JC, Silbernagel KG. Outcome evaluation in tendinopathy: foundations of assessment and a summary of selected measures. *J Orthop Sports Phys Ther*. 2015;45:950-964. https://doi.org/10.2519/jospt.2015.6054

114. MacDermid JC, Walton DM, Law M. Critical appraisal of research evidence for its validity and usefulness. *Hand Clin*. 2009;25:29-42. https://doi.org/10.1016/j.hcl.2008.11.003

115. MacDermid JC, Wojkowski S, Kargus C, Marley M, Stevenson E. Hand therapist management of the lateral epicondylosis: a survey of expert opinion and practice patterns. *J Hand Ther*. 2010;23:18-30. https://doi.org/10.1016/j.jht.2009.09.009

116. Macedo LB, Josué AM, Maia PHB, Câmara AE, Brasileiro JS. Effect of burst TENS and conventional TENS combined with cryotherapy on pressure pain threshold: randomised, controlled, clinical trial. *Physiotherapy*. 2015;101:155-160. https://doi.org/10.1016/j.physio.2014.07.004

117. Magee JD. *Orthopedic Physical Assessment*. 6th ed. St. Louis, MO: Saunders; 2013.

118. Mansiz-Kaplan B, Pervane-Vural S, Celik OF, Genc H. Comparison of the effects of using non-steroidal anti-inflammatory drugs with or without kinesio taping on the radial nerve in lateral epicondylitis: a randomized-single blind study. *EXPLORE*. 2021:17;327-333. https://doi.org/10.1016/j.explore.2020.07.008

119. Mansoori A, Noorizadeh Dehkordi S, Mansour Sohani S, Nodehi Moghadam A. Cross-cultural adaptation and determination of the validity and reliability of the Persian version of the Patient-Rated Tennis Elbow Evaluation (PRTEE) Questionnaire in Iranian tennis players. *Funct Disabil J*. 2019;2:17-26. https://doi.org/10.30699/fdisj.1.4.17

120. Marks M, Rickenbacher D, Audigé L, Glanzmann MC. Patient-Rated Tennis Elbow Evaluation (PRTEE). *Zeitschrift für Orthopädie und Unfallchirurgie*. 2021;159:391-396. https://doi.org/10.1055/a-1107-3313

121. Martínez-Beltrán MJ, Rodríguez-Sanz D, Pérez-Mallada N. Are there any changes in strength after the application of Kinesio taping in lateral epicondylalgia? *J Back Musculoskelet Rehabil*. 2021;34:775-781. https://doi.org/10.3233/BMR-200325

122. Martinez-Silvestrini JA, Newcomer KL, Gay RE, Schaefer MP, Kortebein P, Arendt KW. Chronic lateral epicondylitis: comparative effectiveness of a home exercise program including stretching alone versus stretching supplemented with eccentric or concentric strengthening. *J Hand Ther*. 2005;18:411-419. https://doi.org/10.1197/j.jht.2005.07.007

123. Miller TT, Shapiro MA, Schultz E, Kalish PE. Comparison of sonography and MRI for diagnosing epicondylitis. *J Clin Ultrasound*. 2002;30:193-202. https://doi.org/10.1002/jcu.10063

124. Mills PG. Treatment of tennis elbow. *Br Med J*. 1937;2:212-213.

125. Milz S, Tischer T, Buettner A, et al. Molecular composition and pathology of entheses on the medial and lateral epicondyles of the humerus: a structural basis for epicondylitis. *Ann Rheum Dis*. 2004;63:1015-1021. https://doi.org/10.1136/ard.2003.016378

126. Morrey FB. *The Elbow and Its Disorders*. 2nd ed. Philadelphia, PA: W.B. Saunders Co; 1993.

127. Mostafaee N, Divandari A, Negahban H, et al. Shoulder and scapula muscle training plus conventional physiotherapy versus conventional physiotherapy only: a randomized controlled trial of patients with lateral elbow tendinopathy. *Physiother Theory Pract*. 2020;38:1-12. https://doi.org/10.1080/09593985.2020.1821417

128. Nagrale AV, Herd CR, Ganvir S, Ramteke G. Cyriax physiotherapy versus phonophoresis with supervised exercise in subjects with lateral epicondylalgia: a randomized clinical trial. *J Man Manip Ther*. 2009;17:171-178. https://doi.org/10.1179/jmt.2009.17.3.171

129. Navarro-Santana MJ, Sanchez-Infante J, Gómez-Chiguano GF, et al. Effects of trigger point dry needling on lateral epicondylalgia of musculoskeletal origin: a systematic review and meta-analysis. *Clin Rehabil*. 2020;34:1327-1340. https://doi.org/10.1177/0269215520937468

130. Neumann AD. *Kinesiology of the Musculoskeletal System: Foundations for Rehabilitation*. 3rd ed. St. Louis, MO: Mosby; 2016.

131. Newcomer KL, Martinez-Silvestrini JA, Schaefer MP, Gay RE, Arendt KW. Sensitivity of the Patient-rated Forearm Evaluation Questionnaire in lateral epicondylitis. *J Hand Ther*. 2005;18:400-406. https://doi.org/10.1197/j.jht.2005.07.001

132. Nilsson P, Baigi A, Marklund B, Månsson J. Cross-cultural adaptation and determination of the reliability and validity of PRTEE-S (Patientskattad Utvärdering av Tennisarmbåge), a questionnaire for patients with lateral epicondylalgia, in a Swedish population. *BMC Musculoskelet Disord*. 2008;9. https://doi.org/10.1186/1471-2474-9-79

133. Nilsson P, Baigi A, Swärd L, Möller M, Månsson J. Lateral epicondylalgia: a structured programme better than corticosteroids and NSAID. *Scand J Occup Ther*. 2012;19:404-410. https://doi.org/10.3109/11038128.2011.620983

134. Nilsson P, Thom E, Baigi A, Marklund B, Månsson J. A prospective pilot study of a multidisciplinary home training programme for lateral epicondylitis. *Musculoskelet Care*. 2007;5:36-50. https://doi.org/10.1002/msc.97

135. Nirschl PR. The epidemiology and health care burden of tennis elbow: a population-based study. *Ann Transl Med*. 2015;3:133. https://doi.org/10.3978/j.issn.2305-5839.2015.05.05

136. Oken O, Kahraman Y, Ayhan F, Canpolat S, Yorgancioglu ZR, Oken OF. The short-term efficacy of laser, brace, and ultrasound treatment in lateral epicondylitis: a prospective, randomized, controlled trial. *J Hand Ther*. 2008;21:63-67. https://doi.org/10.1197/j.jht.2007.09.003

137. Olaussen M, Holmedal O, Lindbaek M, Brage S, Solvang H. Treating lateral epicondylitis with corticosteroid injections or non-electrotherapeutical physiotherapy: a systematic review. *BMJ Open*. 2013;3:e003564. https://doi.org/10.1136/bmjopen-2013-003564

138. Overend TJ, Wuori-Fearn JL, Kramer JF, MacDermid JC. Reliability of a patient-rated forearm evaluation questionnaire for patients with lateral epicondylitis. *J Hand Ther*. 1999;12:31-37. https://doi.org/10.1016/S0894-1130(99)80031-3

139. Özmen T, Koparal SS, Karatas Ö, Eser F, Özkurt B, Gafuroglu TÜ. Comparison of the clinical and sonographic effects of ultrasound therapy, extracorporeal shock wave therapy, and Kinesio taping in lateral epicondylitis. *Turk J Med Sci*. 2021;51:76-83. https://doi.org/10.3906/sag-2001-79

140. Paoloni JA, Murrell GAC. Identification of prognostic indicators for patient outcomes in extensor tendinopathy at the elbow. *Scand J Med Sci Sports*. 2004;14:163-167. https://doi.org/10.1111/j.1600-0838.2004.00358.x

141. Park HB, Gwark J-Y, Im J-H, Na J-B. Factors associated with lateral epicondylitis of the elbow. *Orthop J Sports Med*. 2021;9:232596712110077. https://doi.org/10.1177/23259671211007734

142. Pasternack I, Tuovinen EM, Lohman M, Vehmas T, Malmivaara A. MR findings in humeral epicondylitis. A systematic review. *Acta Radiol (Stockh Swed 1987)*. 2001;42:434-440.

143. Petherick M, Rheault W, Kimble S, Lechner C, Senear V. Concurrent validity and intertester reliability of universal and fluid-based goniometers for active elbow range of motion. *Phys Ther*. 1988;68:966-969. https://doi.org/10.1093/ptj/68.6.966

144. Pienimäki T, Karinen P, Kemilä T, Koivukangas P, Vanharanta H. Long-term follow-up of conservatively treated chronic tennis elbow patients. A prospective and retrospective analysis. *Scand J Rehabil Med*. 1998;30:159-166. https://doi.org/10.1080/003655098444093

145. Pienimäki T, Tarvainen T, Siira P, Malmivaara A, Vanharanta H. Associations between pain, grip strength, and manual tests in the treatment evaluation of chronic tennis elbow. *Clin J Pain*. 2002;18:164-170. https://doi.org/10.1097/00002508-200205000-00005

146. Pienimäki TT, Tarvainen TK, Siira PT, Vanharanta H. Progressive strengthening and stretching exercises and ultrasound for chronic lateral epicondylitis. *Physiotherapy*. 1996;82:522-530. https://doi.org/10.1016/S0031-9406(05)66275-X

147. Plinsinga M, Brink M, Vicenzino B, Van Wilgen C. Evidence of nervous system sensitization in commonly presenting and persistent painful tendinopathies: a systematic review. *J Orthop Sports Phys Ther*. 2015;45:864-875. https://doi.org/10.2519/jospt.2015.5895

148. Poltawski L, Watson T. Measuring clinically important change with the Patient-rated Tennis Elbow Evaluation. *Hand Ther*. 2011;16:52-57. https://doi.org/10.1258/ht.2011.011013

149. Qi L, Zhang Y-D, Yu R-B, Shi H-B. Magnetic resonance imaging of patients with chronic lateral epicondylitis: is there a relationship between magnetic resonance imaging abnormalities of the common extensor tendon and the patient's clinical symptom? *Medicine*. 2016;95:e2681. https://doi.org/10.1097/MD.0000000000002681

150. Raman J, MacDermid JC, Grewal R. Effectiveness of different methods of resistance exercises in lateral epicondylosis–a systematic review. *J Hand Ther*. 2012;25:5-25. https://doi.org/10.1016/j.jht.2011.09.001

151. Reyhan AC, Sindel D, Dereli EE. The effects of Mulligan's mobilization with movement technique in patients with lateral epicondylitis. *J Back Musculoskelet Rehabil*. 2020;33:99-107. https://doi.org/10.3233/BMR-181135

152. Rodríguez-Huguet M, Góngora-Rodríguez J, Lomas-Vega R, et al. Percutaneous electrolysis in the treatment of lateral epicondylalgia: a single-blind randomized controlled trial. *J Clin Med*. 2020;33:2068. https://doi.org/10.3390/jcm9072068

153. Roh YH, Gong HS, Baek GH. The prognostic value of pain sensitization in patients with lateral epicondylitis. *J Hand Surg*. 2019;44:250.E1-250.E7. https://doi.org/10.1016/j.jhsa.2018.06.013

154. Roles NC, Maudsley RH. Radial tunnel syndrome: resistant tennis elbow as a nerve entrapment. *J Bone Jt Surg*. 1972;54:499-508. https://doi.org/10.1302/0301-620X.54B3.499

155. Rompe JD, Overend TJ, MacDermid JC. Validation of the Patient-rated Tennis Elbow Evaluation Questionnaire. *J Hand Ther*. 2007;20:3-11. https://doi.org/10.1197/j.jht.2006.10.003

156. Ruch DS, Papadonikolakis A, Campolattaro RM. The posterolateral plica: a cause of refractory lateral elbow pain. *J Shoulder Elb Surg*. 2006;15:367-370. https://doi.org/10.1016/j.jse.2005.08.013

157. Salaffi F, Stancati A, Silvestri CA, Ciapetti A, Grassi W. Minimal clinically important changes in chronic musculoskeletal pain intensity measured on a numerical rating scale. *Eur J Pain*. 2004;8:283-291. https://doi.org/10.1016/j.ejpain.2003.09.004

158. Sanders TL, Maradit Kremers H, Bryan AJ, Ransom JE, Smith J, Morrey BF. The epidemiology and health care burden of tennis elbow: a population-based study. *Am J Sports Med*. 2015;43:1066-1071. https://doi.org/10.1177/0363546514568087

159. Saroja G, Aseer ALP, Reader in physiotherapy SRU, et al. Diagnostic accuracy of provocative tests in lateral epicondylitis. *Int J Physiother Res*. 2014;2:815-823. https://doi.org/10.16965/ijpr.2014.699

160. Schmitt JS, Di Fabio RP. Reliable change and minimum important difference (MID) proportions facilitated group responsiveness comparisons using individual threshold criteria. *J Clin Epidemiol*. 2004;57:1008-1018. https://doi.org/10.1016/j.jclinepi.2004.02.007

161. Schneeberger AG, Masquelet AC. Arterial vascularization of the proximal extensor carpi radialis brevis tendon. *Clin Orthop Relat Res*. 2002;239-244.

162. Scott A, Backman L, Speed C. Tendinopathy: update on pathophysiology. *J Orthop Sports Phys Ther*. 2015;45:833-841. https://doi.org/10.2519/jospt.2015.5884

163. Selvanetti A, Barrucci A, Antonaci A, Martinez P, Marra S, Necozione S. L'esercizio eccentrico nella rieducazione funzionale dell'epicondilite. 2003;56:103-113.

164. Sethi K, Noohu MM. Scapular muscles strengthening on pain, functional outcome and muscle activity in chronic lateral epicondylalgia. *J Orthop Sci*. 2018;23:777-782. https://doi.org/10.1016/j.jos.2018.05.003

165. Sevier TL, Stegink-Jansen CW. Astym treatment vs. eccentric exercise for lateral elbow tendinopathy: a randomized controlled clinical trial. *PeerJ*. 2015;3:e967. https://doi.org/10.7717/peerj.967

166. Shafiee E, Farzad M, Macdermid J, Smaeel Beygi A, Vafaei A, Farhoud A. Cross-cultural adaptation and measurement properties of the Patient-Rated Tennis Elbow Evaluation for the Persian language. *Hand Ther*. 2020;25:56-62. https://doi.org/10.1177/1758998320910177

167. Shahabi S, Bagheri Lankarani K, Heydari ST, et al. The effects of counterforce brace on pain in subjects with lateral elbow tendinopathy: a systematic review and meta-analysis of randomized controlled trials. *Prosthet Orthot Int*. 2020;44:341-354. https://doi.org/10.1177/0309364620930618

168. Shamsoddini A, Hollisaz MT. Effects of taping on pain, grip strength and wrist extension force in patients with tennis elbow. *Trauma Mon*. 2013;18:71-74. https://doi.org/10.5812/traumamon.12450

169. Shamsoddini A, Hollisaz MT, Hafezi R. Initial effect of taping technique on wrist extension and grip strength and pain of Individuals with lateral epicondylitis. *Iran Rehabil J*. 2010;8:24-28.

170. Shiri R, Viikari-Juntura E. Lateral and medial epicondylitis: role of occupational factors. *Best Pract Res Clin Rheumatol*. 2011;25:43-57. https://doi.org/10.1016/j.berh.2011.01.013

171. Shiri R, Viikari-Juntura E, Varonen H, Heliövaara M. Prevalence and determinants of lateral and medial epicondylitis: a population study. *Am J Epidemiol*. 2006;164:1065-1074. https://doi.org/10.1093/aje/kwj325

172. Sims SEG, Miller K, Elfar JC, Hammert WC. Non-surgical treatment of lateral epicondylitis: a systematic review of randomized controlled trials. *HAND*. 2014:419-446. https://doi.org/10.1007/s11552-014-9642-x

173. Smidt N, van der Windt DA, Assendelft WJ, et al. Interobserver reproducibility of the assessment of severity of complaints, grip strength, and pressure pain threshold in patients with lateral epicondylitis. *Arch Phys Med Rehabil*. 2002;83:1145-1150. https://doi.org/10.1053/apmr.2002.33728

174. Sölveborn SA, Olerud C. Radial epicondylalgia (tennis elbow): measurement of range of motion of the wrist and the elbow. *J Orthop Sports Phys Ther*. 1996;23:251-257. https://doi.org/10.2519/jospt.1996.23.4.251

175. Stasinopoulos D, Papadopoulos C, Antoniadou M, Nardi L. Greek adaptation and validation of the Patient-Rated Tennis Elbow Evaluation (PRTEE). *J Hand Ther*. 2015;28:286-291. https://doi.org/10.1016/j.jht.2014.12.005

176. Steinert AF, Goebel S, Rucker A, Barthel T. Snapping elbow caused by hypertrophic synovial plica in the radiohumeral joint: a report of three cases and review of literature. *Arch Orthop Trauma Surg*. 2010;130:347-351. https://doi.org/10.1007/s00402-008-0798-0

177. Stratford P, Gill C, Westaway M, Binkley J. Assessing disability and change on individual patients: a report of a patient specific measure. *Physiother Can*. 1995;47:258-263. https://doi.org/10.3138/ptc.47.4.258

178. Stratford PW, Levy DR, Gauldie S, Miseferi D, Levy K. The evaluation of phonophoresis and friction massage as treatments for extensor carpi radialis tendinitis: a randomized controlled trial. *Physiother Can*. 1989;41:93-99.

179. Stratford PW, Levy DR, Gowland C. Evaluative properties of measures used to assess patients with lateral epicondylitis. *Sci Open*. 1993;45.

180. Stratford PW, Levy DR. Assessing valid change over time in patients with lateral epicondylitis at the elbow. *Clin J Sport Med*. 1994;4:88-91. https://doi.org/10.1097/00042752-199404000-00004

181. Struijs PAA, Damen P-J, Bakker EWP, Blankevoort L, Assendelft WJJ, van Dijk CN. Manipulation of the wrist for management of lateral epicondylitis: a randomized pilot study. *Phys Ther*. 2003;83:608-616. https://doi.org/10.1093/ptj/83.7.608

182. Tezel N, Can A, Karaahmet Ö, Gürçay E. The effects of kinesiotaping on wrist extensor strength using an isokinetic device in patients with chronic lateral epicondylitis: a randomized-controlled trial. *Turkish J Phys Med Rehabil*. 2020;66:60-66. https://doi.org/10.5606/tftrd.2020.3298

183. Titchener AG, Fakis A, Tambe AA, Smith C, Hubbard RB, Clark DI. Risk factors in lateral epicondylitis (tennis elbow): a case-control study. *J Hand Surg (Eur Vol)*. 2012;38:159-164. https://doi.org/10.1177/1753193412442464

184. Tran T, Harris C, Ciccarelli M. The impact of a hand therapy workplace-based educational approach on the management of lateral elbow tendinopathy: a randomized controlled study. *J Hand Ther*. 2021;S0894-1130:147-142. https://doi.org/10.1016/j.jht.2021.09.004

185. Tumilty S, Munn J, McDonough S, Hurley DA, Basford JR, Baxter GD. Low level laser treatment of tendinopathy: a systematic review with meta-analysis. *Photomed Laser Surg*. 2010;28:3-16. https://doi.org/10.1089/pho.2008.2470

186. Turchin DC, Beaton DE, Richards RR. Validity of observer-based aggregate scoring systems as descriptors of elbow pain, function, and disability. *J Bone Jt Surg*. 1998;80:154-162. https://doi.org/10.2106/00004623-199802000-00002

187. Uygur E, Aktas B, Yilmazoglu EG. The use of dry needling vs. corticosteroid injection to treat lateral epicondylitis: a prospective, randomized, controlled study. *J Shoulder Elb Surg*. 2021;30:134-139. https://doi.org/10.1016/j.jse.2020.08.044

188. Valdes K, LaStayo P. The value of provocative tests for the wrist and elbow: a literature review. *J Hand Ther*. 2013;26:32-42. https://doi.org/10.1016/j.jht.2012.08.005

189. van Ark M, Zwerver J, Diercks RL, van den Akker-Scheek I. Cross-cultural adaptation and reliability and validity of the Dutch Patient-Rated Tennis Elbow Evaluation (PRTEE-D). *BMC Musculoskelet Disord*. 2014;15:270. https://doi.org/10.1186/1471-2474-15-270

190. Van Rijn RM, Huisstede BMA, Koes BW, Burdorf A. Associations between work-related factors and specific disorders at the elbow: a systematic literature review. *Rheumatology*. 2009;48:528-536. https://doi.org/10.1093/rheumatology/kep013

191. Varatharajan S, Côté P, Shearer HM, et al. Are work disability prevention interventions effective for the management of neck pain or upper extremity disorders? A systematic review by the Ontario Protocol For Traffic Injury Management (OPTIMa) Collaboration. *J Occup Rehabil*. 2014. https://doi.org/10.1007/s10926-014-9501-1

192. Verstreken F, De Smet L, Westhovens R, Fabry G. Results of the Kudo elbow prosthesis in patients with rheumatoid arthritis: a preliminary report. *Clin Rheumatol*. 1998;17:325-328. https://doi.org/10.1007/BF01451014

193. Vicenzino B. Lateral epicondylalgia: a musculoskeletal physiotherapy perspective. *Man Ther*. 2003;8:66-79. https://doi.org/10.1016/S1356-689X(02)00157-1

194. Vicenzino B, Brooksbank J, Minto J, Offord S, Paungmali A. Initial effects of elbow taping on pain-free grip strength and pressure pain threshold. *J Orthop Sports Phys Ther*. 2003;33:400-407. https://doi.org/10.2519/jospt.2003.33.7.400

195. Vicenzino B, Smith D, Cleland J, Bisset L. Development of a clinical prediction rule to identify initial responders to mobilisation with movement and exercise for lateral epicondylalgia. *Man Ther*. 2009;14:550-554. https://doi.org/10.1016/j.math.2008.08.004

196. Vuvan V, Vicenzino B, Mellor R, Heales LJ, Coombes BK. Unsupervised isometric exercise versus wait-and-see for lateral elbow tendinopathy. *Med Sci Sports Exerc*. 2020;52:287-295. https://doi.org/10.1249/MSS.0000000000002128

197. Walker JD. Is this the end of part-time clinical research? *Rheumatology*. 2004;43:806-807. https://doi.org/10.1093/rheumatology/keh159

198. Walker-Bone K, Palmer KT, Reading I, Coggon D, Cooper C. Occupation and epicondylitis: a population-based study. *Rheumatology*. 2012;51:305-310

199. Walton MJ, Mackie K, Fallon M, et al. The reliability and validity of magnetic resonance imaging in the assessment of chronic lateral epicondylitis. *J Hand Surg*. 2011;36:475-479. https://doi.org/10.1016/j.jhsa.2010.11.040

200. Waugh EJ, Jaglal SB, Davis AM. Computer use associated with poor long-term prognosis of conservatively managed lateral epicondylalgia. *J Orthop Sports Phys Ther*. 2004;34:770-780. https://doi.org/10.2519/jospt.2004.34.12.770

201. Waugh EJ, Jaglal SB, Davis AM, Tomlinson G, Verrier MC. Factors associated with prognosis of lateral epicondylitis after 8 weeks of physical therapy. *Arch Phys Med Rehabil*. 2004;85:308-318. https://doi.org/10.1016/S0003-9993(03)00480-5

202. Weng C-S, Shu S-H, Chen C-C, Tsai Y-S, Hu W-C, Chang Y-H. The evaluation of two modulated frequency modes of acupuncture-like tens on

the treatment of tennis elbow pain. *Biomed Eng: Appl Basis Commun*. 2005;17:236-242.

203. Wixom SM, Lastayo P. A potential classification model for individuals with tennis elbow. *J Hand Ther*. 2012;25:418-420. https://doi.org/10.1016/j.jht.2012.06.007

204. Word Health Organization. *International Classification of Functioning, Disability and Health: ICF*. Geneva, Switzerland: World Health Organization; 2009.

205. Smidt N, Assendelft W, Arola H, et al. Effectiveness of physiotherapy for lateral epicondylitis: a systematic review. *Ann Med*. 2003;35:51-62. https://doi.org/10.1080/07853890310004138

206. Yalvaç B, Mesci N, Geler Külcü D, Yurdakul OV. Comparison of ultrasound and extracorporeal shock wave therapy in lateral epicondylosis. *Acta Orthop Traumatol Turc*. 2018;52:357-362. https://doi.org/10.1016/j.aott.2018.06.004

207. Yi R, Bratchenko WW, Tan V. Deep friction massage versus steroid injection in the treatment of lateral epicondylitis. *HAND*. 2018;13:56-59. https://doi.org/10.1177/1558944717692088

208. Yoon SY, Kim YW, Shin IS, Kang S, Moon HI, Lee SC. The beneficial effects of eccentric exercise in the management of lateral elbow tendinopathy: a systematic review and meta-analysis. *J Clin Med*. 2021;10:3968. https://doi.org/10.3390/jcm10173968

209. Zhong Y, Zheng C, Zheng J, Xu S. Kinesio tape reduces pain in patients with lateral epicondylitis: a meta-analysis of randomized controlled trials. *Int J Surg (Lond Eng)*. 2020;76:190-199. https://doi.org/10.1016/j.ijsu.2020.02.044

210. Zunke P, Auffarth A, Hitzl W, Moursy M. The effect of manual therapy to the thoracic spine on pain-free grip and sympathetic activity in patients with lateral epicondylalgia humeri. A randomized, sample sized planned, placebo-controlled, patient-blinded monocentric trial. *BMC Musculoskelet Disord*. 2020;21:186

211. Zwerus EL, Somford MP, Maissan F, Heisen J, Eygendaal D, van den Bekerom MP. Physical examination of the elbow, what is the evidence? A systematic literature review. *Br J Sports Med*. 2018;52:1253-1260. https://doi.org/10.1136/bjsports-2016-096712

212. Zwerus EL, Willigenburg NW, Scholtes VA, Somford MP, Eygendaal D, van den Bekerom MP. Normative values and affecting factors for the elbow range of motion. *Shoulder Elbow*. 2019;11:215-224. https://doi.org/10.1177/1758573217728711

APPENDIX A

SEARCH STRATEGIES AND SEARCH RESULTS (JANUARY 1, 2001, THROUGH NOVEMBER 30, 2021)

Outcome Measures Search Results (March 17, 2022)

Outcome Measures	PubMed Results	CINAHL Results	Cochrane Library Results	Total Results from Databases	Total Duplicates Removed	Articles Remaining to Screen
Self-report measures	1301	71	64	1436	325	1111
Clinician-based and impairment measures	1595	109	76	1780	415	1365

Intervention Search Results (March 17, 2022)

Intervention	PubMed Results	CINAHL Results	Cochrane Library Results	Total Results from Databases	Total Duplicates Removed	Articles Remaining to Screen
Exercise	329	289	435	1053	511	542
Manual therapy	103	121	138	362	247	115
Soft tissue	30	44	60	134	77	57
Dry needling	25	16	49	90	52	38
Orthotics	166	153	200	519	254	265
Taping	70	68	122	260	191	69
Thermal modalities	58	60	111	229	124	105
Ultrasound	63	61	43	167	96	71
Phonophoresis	8	12	12	32	12	20
Iontophoresis	17	16	19	52	34	18
TENS	17	132	44	193	75	118
Low-level laser	58	42	84	184	111	73
Acupuncture	54	48	88	190	110	80
Ergonomics	532	420	314	1266	617	649

Abbreviations: CINAHL, Cumulative Index to Nursing and Allied Health Literature; TENS, transcutaneous electrical nerve stimulation.

Outcome Measures and Prognosis

Search Topic	Terms PubMed	Terms CINAHL	Terms Cochrane Library
Lateral elbow tendinopathy	"Tennis Elbow"[Mesh] OR "tennis elbow"[tw] OR "lateral elbow tendinopathy"[tw] OR "lateral elbow tendinitis"[tw] OR "lateral epicondylit*"[tw] OR "lateral epicondylos*"[tw] OR "lateral epicondylalgia"[tw] OR "lateralis epicondylitis humeri"[tw] OR "lateralis epicondylalgia humeri"[tw] OR "lateral humeral epicondylit*"[tw] OR "lateral elbow tendinopathy"[tw] OR (("Elbow Tendinopathy"[Mesh] OR epicondyl*[tw] OR "Tendinopathy"[Mesh] OR tendinitis[tw] OR tendonitis[tw] OR tendinopathy[tw] OR tendinosis[tw] OR tendinalgia[tw] OR peritendinitis[tw] OR enthesopathy[tw]) AND lateral[tw])	MH "Tennis Elbow" OR "tennis elbow" OR "lateral elbow tendinopathy" OR "lateral elbow tendinitis" OR "lateral epicondylit*" OR "lateral epicondylos*" OR "lateral epicondylalgia" OR "lateralis epicondylitis humeri" OR "lateralis epicondylalgia humeri" OR "lateral humeral epicondylit*" OR "lateral elbow tendinopathy" OR ((MH "Elbow Injuries" OR epicondyl* OR MH "Tendinopathy" OR tendinitis OR tendonitis OR tendinopathy OR tendinosis OR tendinalgia OR peritendinitis OR enthesopathy) AND lateral)	[mh "Tennis Elbow"] OR "tennis elbow":ti,ab,kw OR "lateral elbow tendinopathy":ti,ab,kw OR "lateral elbow tendinitis":ti,ab,kw OR ("lateral" NEXT epicondylit*):ti,ab,kw OR ("lateral" NEXT epicondylos*):ti,ab,kw OR "lateral epicondylalgia":ti,ab,kw OR "lateralis epicondylitis humeri":ti,ab,kw OR "lateralis epicondylalgia humeri":ti,ab,kw OR ("lateral humeral" NEXT epicondylit*):ti,ab,kw OR "lateral elbow tendinopathy":ti,ab,kw OR (([mh "Elbow Tendinopathy"] OR epicondyl*:ti,ab,kw OR [mh Tendinopathy] OR tendinitis:ti,ab,kw OR tendonitis:ti,ab,kw OR tendinopathy:ti,ab,kw OR tendinosis:ti,ab,kw OR tendinalgia:ti,ab,kw OR peritendinitis:ti,ab,kw OR enthesopathy:ti,ab,kw) AND lateral:ti,ab,kw)

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APPENDIX A (CONTINUED)

Search Topic	Terms PubMed	Terms CINAHL	Terms Cochrane Library
Clinical measurement properties	SRM OR "Standardized response means"[tw] OR ES OR "effect sizes" OR "Standard error of measurement" OR SEM OR MDC OR "Minimal Detectable Change"[tw] OR MCID OR "Minimally Clinical Important difference"[tw] OR "Sensitivity to change"[tw] OR responsiveness[tw] OR reliability[tw] OR Validity[tw] OR validation[tw] OR precision[tw] OR ROC OR "Receiver operating curve"[tw] OR Floor and ceiling effects[tw]) OR sensitivity[tw] OR specificity[tw] OR "likelihood ratio"[tw] OR reproducibility[tw]	"SRM" OR "Standardized response means" OR "ES" OR "effect sizes" OR "Standard error of measurement" OR "SEM" OR "MDC" OR "Minimal Detectable Change" OR "MCID" OR "Minimally Clinical Important difference" OR "Sensitivity to change" OR "responsiveness" OR "reliability" OR "Validity" OR "validation" OR "precision" OR "ROC" OR "Receiver operating curve" OR "Floor and ceiling effects" OR "sensitivity" OR "specificity" OR "likelihood ratio" OR "reproducibility"	SRM OR Standardized response means OR ES OR effect sizes OR standard error of measurement OR SEM OR MDC OR Minimal Detectable Change OR MCID OR Minimally Clinical Important difference OR Sensitivity to change OR responsiveness OR reliability OR Validity OR validation OR precision OR ROC OR Receiver operating curve OR Floor and ceiling effects OR sensitivity OR specificity OR likelihood ratio OR reproducibility
Self-report measures	DASH OR Disabilities of the arm shoulder and the hand[tw] OR Quick DASH OR Visual analog scale[tw] OR VAS OR Visual Analog Scale[tw] OR NRS OR Numeric Rating Scale[tw] OR NPRS OR Numeric pain rating scale[tw] OR PRFEQ OR Patient rated tennis elbow evaluation[tw] OR Patient rated forearm evaluation questionnaire[tw] OR PRTEE OR PSFS OR "Patient Specific Functional Scale"[tw]	"DASH" OR "Disabilities of the arm shoulder and the hand" OR "Quick DASH" OR "Visual analog scale" OR "VAS" OR "Visual Analog Scale" OR "NRS" OR "Numeric Rating Scale" OR "NPRS" OR "Numeric pain rating scale" OR "PRFEQ" OR "Patient rated tennis elbow evaluation" OR "Patient rated forearm evaluation questionnaire" OR "PRTEE" OR PSFS OR "Patient Specific Functional Scale"	DASH OR Disabilities of the arm shoulder and the hand OR Quick DASH OR VAS OR Visual Analog Scale OR NRS OR Numeric Rating Scale OR NPRS OR Numeric pain rating scale OR PRFEQ OR Patient rated tennis elbow evaluation OR Patient rated forearm evaluation questionnaire OR PRTEE OR PSFS OR Patient Specific Functional Scale
Impairment measures	"strength test"[tw] OR "Manual muscle test"[tw] OR "range of motion"[tw] OR "elbow range of motion"[tw] OR "forearm range of motion"[tw] OR "wrist range of motion"[tw] OR flexibility[tw] OR full movement[tw] OR "grip strength"[tw] OR "pain-free grip strength"[tw] OR "Mayo Elbow Performance Index"[tw] OR "MEPI"[tw] OR "Roles and Maudsley score"[tw] OR "RM Score"[tw] OR "Pressure pain threshold"[tw] OR PPT[tw]	"strength test" OR "Manual muscle test" OR "range of motion" OR "elbow range of motion" OR "forearm range of motion" OR "wrist range of motion" OR flexibility OR full movement OR "grip strength" OR "pain-free grip strength" OR "Mayo Elbow Performance Index" OR "MEPI" OR "Roles and Maudsley score" OR "RM Score" OR "Pressure pain threshold" OR PPT	strength test OR Manual muscle test OR range of motion OR elbow range of motion OR forearm range of motion OR wrist range of motion OR flexibility OR grip strength OR pain-free grip strength OR Mayo Elbow Performance Index OR MEPI OR Roles and Maudsley score OR RM Score OR Pressure pain threshold OR PPT

Abbreviation: CINAHL, Cumulative Index to Nursing and Allied Health Literature.

Interventions

Search Topic	Terms PubMed	Terms CINAHL	Terms Cochrane Library
	"Tennis Elbow"[Mesh] OR "tennis elbow"[tw] OR "lateral elbow tendinopathy"[tw] OR "lateral elbow tendinitis"[tw] OR "lateral epicondylit*"[tw] OR "lateral epicondylos*"[tw] OR "lateral epicondylalgia"[tw] OR "lateralis epicondylitis humeri"[tw] OR "lateralis epicondylalgia humeri"[tw] OR "lateral humeral epicondylit*"[tw] OR "lateral elbow tendinopathy"[tw] OR (("Elbow Tendinopathy"[Mesh] OR epicondyl*[tw] OR "Tendinopathy"[Mesh] OR tendinitis[tw] OR tendonitis[tw] OR tendinopathy[tw] OR tendinosis[tw] OR tendinalgia[tw] OR peritendinitis[tw] OR enthesopathy[tw]) AND lateral[tw])	MH "Tennis Elbow" OR "tennis elbow" OR "lateral elbow tendinopathy" OR "lateral elbow tendinitis" OR "lateral epicondylit*" OR "lateral epicondylos*" OR "lateral epicondylalgia" OR "lateralis epicondylitis humeri" OR "lateralis epicondylalgia humeri" OR "lateral humeral epicondylit*" OR "lateral elbow tendinopathy" OR ((MH "Elbow Injuries" OR epicondyl* OR MH "Tendinopathy" OR tendinitis OR tendonitis OR tendinopathy OR tendinosis OR tendinalgia OR peritendinitis OR enthesopathy) AND lateral)	[mh "Tennis Elbow"] OR "tennis elbow":ti,ab,kw OR "lateral elbow tendinopathy":ti,ab,kw OR "lateral elbow tendinitis":ti,ab,kw OR ("lateral" NEXT epicondylit*):ti,ab,kw OR ("lateral" NEXT epicondylos*):ti,ab,kw OR "lateral epicondylalgia":ti,ab,kw OR "lateralis epicondylitis humeri":ti,ab,kw OR "lateralis epicondylalgia humeri":ti,ab,kw OR ("lateral humeral" NEXT epicondylit*):ti,ab,kw OR "lateral elbow tendinopathy":ti,ab,kw OR (([mh "Elbow Tendinopathy"] OR epicondyl*:ti,ab,kw OR [mh Tendinopathy] OR tendinitis:ti,ab,kw OR tendonitis:ti,ab,kw OR tendinopathy:ti,ab,kw OR tendinosis:ti,ab,kw OR tendinalgia:ti,ab,kw OR peritendinitis:ti,ab,kw OR enthesopathy:ti,ab,kw) AND lateral:ti,ab,kw)

Table continues on next page.

APPENDIX A (CONTINUED)

Search Topic	Terms PubMed	Terms CINAHL	Terms Cochrane Library
	("2001"[Date - Publication] : "3000"[Date - Publication]) AND English[language]	DT 2001-2022 AND LA English	Limits: Cochrane Library Publication Date from January 2001 to present
	("clinical trials as topic"[Mesh] OR "clinical trial"[pt] OR "randomized controlled trial"[pt] OR "controlled clinical trial"[pt] OR randomized[tiab] OR randomization[tiab] OR random-allocation[tiab] OR randomly[tiab] OR trial[tiab] OR groups[tiab] OR "Control Groups"[Mesh] OR "Matched-Pair Analysis"[Mesh] OR case-control[tiab] OR case-comparison[tiab] OR case-series[tiab] OR case-study[tiab] OR case-studies[tiab] OR control-group[tiab] OR prospective[tiab] OR "Prospective Studies"[Mesh] OR cohort[tiab] or groups[tiab] OR longitudinal[tiab] OR meta analysis[Publication Type] OR systematic review[Publication Type] OR systematic-review[ti] OR "systematic literature review"[ti] OR meta-analysis[ti] OR meta-analyses[ti] OR scoping-review[ti])	((MH "Clinical Trials") OR (MH "Randomized Controlled Trials") OR (MH "Control Group") OR (MH "Double-Blind Studies") OR (MH "Random Assignment") OR TI RCT) OR ((TI randomized OR AB randomized) OR (TI randomization OR AB randomization) OR (TI random-allocation OR AB random-allocation) OR (TI randomly OR AB randomly) OR (TI trial OR AB trial) OR (TI groups OR AB groups) OR (TI case-control OR AB case-control) OR (TI case-comparison OR AB case-comparison) OR (TI case-series OR AB case-series) OR (TI case-study OR AB case-study) OR (TI case-studies OR AB case-studies) OR (TI control-group OR AB control-group) OR (TI prospective OR AB prospective) OR (TI cohort OR AB cohort) OR (TI groups OR AB groups) OR (TI longitudinal OR AB longitudinal)) OR (PT "meta analysis" OR PT "meta synthesis" OR PT "systematic review" OR PT review OR PT "practice guidelines" OR TI systematic-review OR TI meta-analysis OR TI scoping-review OR TI literature-review OR TI protocol)	n/a
Exercise	("Exercise"[Mesh] OR "Muscle Contraction"[Mesh] OR "Muscle Stretching Exercises"[Mesh] OR exercis*[tw] OR stretch*[tw] OR plyometric*[tw] OR resist*[tw] OR eccentric[tw] OR concentric[tw] OR isometric*[tw] OR isotonic*[tw] OR activat*[tw] OR contract*[tw] OR conditioning[tw] OR training[tw] OR "neuromuscular facilitation"[tw])	(MH "Exercise+" OR OR MH "Therapeutic Exercise" OR MH "Muscle Contraction+" OR MH "Stretching" OR exercis* OR stretch* OR plyometric* OR resist* OR eccentric OR concentric OR isometric* OR isotonic* OR activat* OR contract* OR conditioning OR training OR "neuromuscular facilitation")	([mh Exercise] OR [mh "Muscle Contraction"] OR [mh "Muscle Stretching Exercises"] OR exercis*:ti,ab,kw OR stretch*:ti,ab,kw OR plyometric*:ti,ab,kw OR resist*:ti,ab,kw OR eccentric:ti,ab,kw OR concentric:ti,ab,kw OR isometric*:ti,ab,kw OR isotonic*:ti,ab,kw OR activat*:ti,ab,kw OR contract*:ti,ab,kw OR conditioning:ti,ab,kw OR training:ti,ab,kw OR "neuromuscular facilitation":ti,ab,kw)
Manual therapy	("Musculoskeletal Manipulations"[Mesh] OR "Manipulation, Chiropractic"[Mesh] OR manipulat*[tw] OR "manual therap*"[tw] OR chiropract*[tw] OR mobilis*[tw] OR mobiliz*[tw] OR cyriax[tw])	(MH "Manual Therapy" OR MH "Manipulation, Chiropractic" OR MH "Manipulation, Orthopedic" OR MH "Manipulation, Osteopathic" OR manipulat* OR "manual therap*" OR chiropract* OR mobilis* OR mobiliz* OR cyriax)	([mh "Musculoskeletal Manipulations"] OR [mh "Manipulation, Chiropractic"] OR manipulat*:ti,ab,kw OR ("manual therap*"):ti,ab,kw OR chiropract*:ti,ab,kw OR mobilis*:ti,ab,kw OR mobiliz*:ti,ab,kw OR cyriax:ti,ab,kw)
Soft tissue	("Massage"[Mesh] OR massag*[tw] OR masseuse*[tw] OR massotherap*[tw] OR "transverse friction"[tw] OR "myofascial release"[tw] OR "soft tissue technique*"[tw] OR "soft tissue mobilis*"[tw] OR "soft tissue mobiliz*"[tw] OR "soft tissue therap*"[tw])	(MH "Massage+" OR MH "Myofascial Release" OR massag* OR masseuse* OR massotherap* OR "transverse friction" OR "myofascial release" OR "soft tissue technique*" OR "soft tissue mobilis*" OR "soft tissue mobiliz*" OR "soft tissue therap*")	([mh Massage] OR massag*:ti,ab,kw OR masseuse*:ti,ab,kw OR massotherap*:ti,ab,kw OR "transverse friction":ti,ab,kw OR "myofascial release":ti,ab,kw OR ("soft tissue technique*"):ti,ab,kw OR ("soft tissue mobilis*"):ti,ab,kw OR ("soft tissue mobiliz*"):ti,ab,kw OR ("soft tissue therap*"):ti,ab,kw)

Table continues on next page.

APPENDIX A (CONTINUED)

Search Topic	Terms PubMed	Terms CINAHL	Terms Cochrane Library
Dry Needling	"Dry Needling"[Mesh] OR needling[tw] OR "dry needle*"[tw] OR "intramuscular stimulation"[tw]	MH "Dry Needling" OR needling OR "dry needle*" OR "intramuscular stimulation"	[mh "Dry Needling"] OR needling:ti,ab,kw OR ("dry needle*"):ti,ab,kw OR "intramuscular stimulation":ti,ab,kw
Orthotics	("Orthotic Devices"[Mesh] OR "Splints"[Mesh] OR orthoses[tw] OR orthotic*[tw] OR orthosis[tw] OR device*[tw] OR brace*[tw] OR bracing[tw] OR splint*[tw] OR sleeve*[tw] OR binder*[tw] OR fixator*[tw] OR cast*[tw] OR counterforce[tw] OR band[tw] OR bands[tw] OR armband*[tw] OR "elbow support*"[tw] OR "wrist support*"[tw] OR "external support*"[tw] OR immobilis*[tw] OR immobiliz*[tw])	MH "Orthoses" OR MH "Orthoses Design" OR MH "Orthoses Fitting" OR MH "Slings" OR MH "Taping and Strapping" OR orthoses OR orthotic* OR orthosis OR device* OR brace* OR bracing OR splint* OR strap* OR sleeve* OR binder* OR fixator* OR cast* OR counterforce OR band OR bands OR armband* OR "elbow support*" OR "wrist support*" OR "external support*" OR immobilis* OR immobiliz*	([mh "Orthotic Devices"] OR [mh Splints] OR orthoses:ti,ab,kw OR orthotic*:ti,ab,kw OR orthosis:ti,ab,kw OR device*:ti,ab,kw OR brace*:ti,ab,kw OR bracing:ti,ab,kw OR splint*:ti,ab,kw OR sleeve*:ti,ab,kw OR binder*:ti,ab,kw OR fixator*:ti,ab,kw OR cast*:ti,ab,kw OR counterforce:ti,ab,kw OR band:ti,ab,kw OR bands:ti,ab,kw OR armband*:ti,ab,kw OR ("elbow support*"):ti,ab,kw OR ("wrist support*"):ti,ab,kw OR ("external support*"):ti,ab,kw OR immobilis*:ti,ab,kw OR immobiliz*:ti,ab,kw)
Taping	("Athletic Tape"[Mesh] OR tape[tw] OR tapes[tw] OR taping[tw] OR kinesiotap*[tw] OR KT[tiab] OR Rocktap*[tw] OR bandag*[tw] OR wrap*[tw] OR strap*[tw] OR "adhesive band*"[tw] OR stabiliz*[tw] OR stabilis*[tw])	MH "Taping and Strapping" OR MH "Tapes" OR MH "Athletic Tape" OR MH "Kinesiotaping" OR MH "Bandages and Dressings" OR tape OR tapes OR taping OR kinesiotap* OR Rocktap* OR bandag* OR wrap* OR strap* OR "adhesive band*" OR stabiliz* OR stabilis* OR TI(KT) OR AB(KT)	([mh "Athletic Tape"] OR tape:ti,ab,kw OR tapes:ti,ab,kw OR taping:ti,ab,kw OR kinesiotap*:ti,ab,kw OR KT:ti,ab OR Rocktap*:ti,ab,kw OR bandag*:ti,ab,kw OR wrap*:ti,ab,kw OR strap*:ti,ab,kw OR ("adhesive band*"):ti,ab,kw OR stabiliz*:ti,ab,kw OR stabilis*:ti,ab,kw)
Thermal modalities	("Cryotherapy"[Mesh] OR "Cold Temperature"[Mesh] OR "Hot Temperature"[Mesh] OR Temperature[Mesh] OR cryotherap*[tw] OR hypotherm*[tw] OR cold*[tw] OR cool*[tw] OR ice[tw] OR iced[tw] OR icing[tw] OR freez*[tw] OR frozen[tw] OR warm[tw] OR hot[tw] OR heat*[tw] OR hypertherm*[tw] OR therm*[tw] OR temperature*[tw] OR fahrenheit[tw] OR celsius[tw] OR kelvin[tw])	MH "Cryotherapy" OR MH "Heat-Cold Application" OR MH "Heat Therapeutic Use" OR MH "Temperature" OR cryotherap* OR hypotherm* OR cold* OR cool* OR ice OR iced OR icing OR freez* OR frozen OR warm OR hot OR heat* OR hypertherm* OR therm* OR temperature* OR fahrenheit OR celsius OR kelvin	([mh Cryotherapy] OR [mh "Cold Temperature"] OR [mh "Hot Temperature"] OR [mh Temperature] OR cryotherap*:ti,ab,kw OR hypotherm*:ti,ab,kw OR cold*:ti,ab,kw OR cool*:ti,ab,kw OR ice:ti,ab,kw OR iced:ti,ab,kw OR icing:ti,ab,kw OR freez*:ti,ab,kw OR frozen:ti,ab,kw OR warm:ti,ab,kw OR hot:ti,ab,kw OR heat*:ti,ab,kw OR hypertherm*:ti,ab,kw OR therm*:ti,ab,kw OR temperature*:ti,ab,kw OR fahrenheit:ti,ab,kw OR celsius:ti,ab,kw OR kelvin:ti,ab,kw)
Ultrasound	((("Ultrasonic Therapy"[Mesh] OR "ultrasound therap*"[tw] OR "ultrasonic therap*"[tw] OR "interventional ultrasound"[tw] OR "interventional ultrasonic"[tw] OR "therapeutic ultrasound"[tw] OR "therapeutic ultrasonic"[tw] OR "ultrasound treatment*"[tw] OR "ultrasonic treatment*"[tw]) OR ((ultrasound[tiab] OR ultrasonic[tiab]) AND (Physical Therapy Modalities"[Mesh]))) NOT ((sonograph[tiab] OR sonography[tiab] OR imaging[tiab] OR diagnos*[tiab] OR percutaneous[tiab] OR injection[tiab] OR "extracorporeal shockwave"[tiab]) NOT (therap*[tiab] OR intervention*[tiab] OR treat*[tiab]))	(MH "Ultrasonic Therapy" OR MH "Ultrasonics" OR "ultrasound therap*" OR "ultrasonic therap*" OR "interventional ultrasound" OR "interventional ultrasonic" OR "therapeutic ultrasound" OR "therapeutic ultrasonic" OR "ultrasound treatment*" OR "ultrasonic treatment*") OR (((TI ultrasound OR AB ultrasound) OR (TI ultrasonic OR AB ultrasonic)) AND ((MH "Physical Therapy"+)))) NOT (((TI sonograph OR AB sonograph) OR (TI sonography OR AB sonography) OR (TI imaging OR AB imaging) OR (TI diagnos* OR AB diagnos*) OR (TI percutaneous OR AB percutaneous) OR (TI injection OR AB injection) OR (TI "extracorporeal shockwave" OR AB "extracorporeal shockwave")) NOT ((TI therap* OR AB therap*) OR (TI intervention* OR AB intervention*) OR (TI treat* OR AB treat*))))	((([mh "Ultrasonic Therapy"] OR "ultrasound therap*":ti,ab,kw OR "ultrasonic therap*":ti,ab,kw OR "interventional ultrasound":ti,ab,kw OR "interventional ultrasonic":ti,ab,kw OR "therapeutic ultrasound":ti,ab,kw OR "therapeutic ultrasonic":ti,ab,kw OR "ultrasound treatment*":ti,ab,kw OR "ultrasonic treatment*":ti,ab,kw) OR ((ultrasound:ti,ab OR ultrasonic:ti,ab) AND ([mh "Physical Therapy Modalities"]))) NOT ((sonograph:ti,ab OR sonography:ti,ab OR imaging:ti,ab OR diagnos*:ti,ab OR percutaneous:ti,ab OR injection:ti,ab OR "extracorporeal shockwave":ti,ab) NOT (therap*:ti,ab OR intervention*:ti,ab OR treat*:ti,ab)))

Table continues on next page.

APPENDIX A (CONTINUED)

Search Topic	Terms PubMed	Terms CINAHL	Terms Cochrane Library
Phonophoresis	"Phonophoresis"[Mesh] OR phonophor*[tw] OR sonophor*[tw]	MH "Phonophoresis" OR phonophor* OR sonophor*	[mh Phonophoresis] OR phonophor*:ti,ab,kw OR sonophor*:ti,ab,kw
Iontophoresis	"Iontophoresis"[Mesh] OR iontophor*[tw] OR ionization[tw] OR ionisation[tw] OR "electromotive drug administration"[tw] OR EMDA[tw] OR electrophoresis[tw] OR electroosmosis[tw] OR "direct electrical current"[tw] OR "direct current stimulation"[tw]	MH "Iontophoresis" OR iontophor* OR ionization OR ionisation OR "electromotive drug administration" OR EMDA OR electrophoresis OR electroosmosis OR "direct electrical current" OR "direct current stimulation"	[mh Iontophoresis] OR iontophor*:ti,ab,kw OR ionization:ti,ab,kw OR ionisation:ti,ab,kw OR "electromotive drug administration":ti,ab,kw OR EMDA:ti,ab,kw OR electrophoresis:ti,ab,kw OR electroosmosis:ti,ab,kw OR "direct electrical current":ti,ab,kw OR "direct current stimulation":ti,ab,kw
TENS	"Transcutaneous Electric Nerve Stimulation"[Mesh] OR "transcutaneous electrical nerve stimulation"[tw] OR "transcutaneous electrical nerve stimulator*"[tw] OR "transcutaneous nerve stimulator*"[tw] OR TENS[tiab] OR "transdermal electrostimulation"[tw] OR "transcutaneous nerve stimulation"[tw] OR "transcutaneous electrical stimulation"[tw] OR "nerve stimulat*"[tw] OR neurostimulation[tw] OR electroanalgesia[tw] OR "analgesic cutaneous electrostimulation"[tw]	MH "Transcutaneous Electric Nerve Stimulation" OR "transcutaneous electrical nerve stimulation" OR "transcutaneous electrical nerve stimulator*" OR "transcutaneous nerve stimulator*" OR "transdermal electrostimulation" OR "transcutaneous nerve stimulation" OR "transcutaneous electrical stimulation" OR "nerve stimulat*" OR neurostimulation OR electroanalgesia OR "analgesic cutaneous electrostimulation" OR TI (TENS) OR AB (TENS)	[mh "Transcutaneous Electric Nerve Stimulation"] OR "transcutaneous electrical nerve stimulation":ti,ab,kw OR "transcutaneous electrical nerve stimulator*":ti,ab,kw OR "transcutaneous nerve stimulator*":ti,ab,kw OR TENS:ti,ab OR "transdermal electrostimulation":ti,ab,kw OR "transcutaneous nerve stimulation":ti,ab,kw OR "transcutaneous electrical stimulation":ti,ab,kw OR "nerve stimulat*":ti,ab,kw OR neurostimulation:ti,ab,kw OR electroanalgesia:ti,ab,kw OR "analgesic cutaneous electrostimulation":ti,ab,kw
Low-level laser	"Low-Level Light Therapy"[MeSH] OR "Laser Therapy"[MeSH] OR "low-level light therap*"[tw] OR "low-level laser therap*"[tw] OR "low-power light therap*"[tw] OR "low-power laser therap*"[tw] OR "low-power laser irradiation"[tw] OR LLLT[tw] OR photobiomodulation[tw] OR "laser biostimulation"[tw] OR "laser phototherap*"[tw] OR light*[tw] OR laser*[tw]	MH "Phototherapy" OR MH "Laser Therapy" OR MH "Lasers" OR MH "Phototherapy" OR "low-level light therap*" OR "low-level laser therap*" OR "low-power light therap*" OR "low-power laser therap*" OR "low-power laser irradiation" OR LLLT OR photobiomodulation OR "laser biostimulation" OR "laser phototherap*" OR light* OR laser*	[mh "Low-Level Light Therapy"] OR [mh "Laser Therapy"] OR "low-level light therap*":ti,ab,kw OR "low-level laser therap*":ti,ab,kw OR "low-power light therap*":ti,ab,kw OR "low-power laser therap*":ti,ab,kw OR "low-power laser irradiation":ti,ab,kw OR LLLT:ti,ab,kw OR photobiomodulation:ti,ab,kw OR "laser biostimulation":ti,ab,kw OR "laser phototherap*":ti,ab,kw OR light*:ti,ab,kw OR laser*:ti,ab,kw
Acupuncture	"Acupuncture Therapy"[Mesh] OR "Acupuncture Points"[Mesh] OR "Acupuncture"[Mesh] OR "Electroacupuncture"[Mesh] OR acupunctur*[tw] OR electroacupunctur*[tw] OR acupoint*[tw]	MH "Acupuncture" OR MH "Electroacupuncture" OR MH "Meridians+" OR acupunctur* OR electroacupunctur* OR acupoint*	[mh "Acupuncture Therapy"] OR [mh "Acupuncture Points"] OR [mh Acupuncture] OR [mh Electroacupuncture] OR acupunctur*:ti,ab,kw OR electroacupunctur*:ti,ab,kw OR acupoint*:ti,ab,kw
Ergonomics	"Ergonomics"[Mesh] OR ergonomic*[tw] OR "human engineering"[tw] OR "human factors"[tw] OR occupational[tw] OR "functional rehabilitation"[tw] OR "vocational rehabilitation"[tw] OR workplace[tw] OR workload*[tw] OR environment*[tw] OR kinematic[tw] OR posture[tw] OR lifting[tw] OR motion*[tw] OR "movement therap*"[tw] OR "movement-based therap*"[tw] OR design[tw] OR layout[tw] OR force[tw] OR counterforce[tw] OR geometry[tw] OR "assistive technolog*"[tw] OR reeducation[tw] OR "re-education"[tw]	MH "Ergonomics+" OR ergonomic* OR "human engineering" OR "human factors" OR occupational OR "functional rehabilitation" OR "vocational rehabilitation" OR workplace OR workload* OR environment* OR kinematic OR posture OR lifting OR "movement therap*" OR "movement-based therap*" OR design OR layout OR force OR counterforce OR geometry OR "assistive technolog*" OR reeducation OR "re-education"	[mh Ergonomics] OR ergonomic*:ti,ab,kw OR biomechanic*:ti,ab,kw OR "human engineering":ti,ab,kw OR "human factors":ti,ab,kw OR occupational:ti,ab,kw OR "functional rehabilitation":ti,ab,kw OR "vocational rehabilitation":ti,ab,kw OR workplace:ti,ab,kw OR workload*:ti,ab,kw OR environment*:ti,ab,kw OR kinematic:ti,ab,kw OR posture:ti,ab,kw OR lifting:ti,ab,kw OR "movement therap*":ti,ab,kw OR "movement-based therapy":ti,ab,kw OR design:ti,ab,kw OR layout:ti,ab,kw OR force:ti,ab,kw OR counterforce:ti,ab,kw OR geometry:ti,ab,kw OR "assistive technolog*":ti,ab,kw OR reeducation:ti,ab,kw OR re-education:ti,ab,kw

Abbreviations: CINAHL, Cumulative Index to Nursing and Allied Health Literature; TENS, transcutaneous electrical nerve stimulation.

APPENDIX B

ARTICLE INCLUSION AND EXCLUSION CRITERIA

Inclusion Criteria

We included articles reporting on lateral elbow tendinopathy that reported information relating to pertinent physical therapist practice on the following topics.

- Epidemiology of the diagnosis, including prevalence and incidence, clinical course, classification, risk factors, and prognosis
- Classification, functional anatomy, and pathophysiology
- Tests and measures for diagnosis and/or differential diagnosis of lateral elbow tendinopathy, including but not limited to "specific tests and measures" and imaging
- Measurement properties of instruments and tests specific to measuring outcomes (including but not limited to symptoms, functions, activity, and participation) that are either specific to the diagnosis of lateral elbow tendinopathy or that measure general UE functional outcomes
- Articles published in peer-reviewed journals that include studies of the following types:
  - Meta-analyses and systematic reviews
  - For time frames not covered in the meta-analyses or systematic reviews, acceptable quality experimental and quasi-experimental, cohort, case series including fewer than 30 participants, and cross-sectional studies were included based on last dates searched in the secondary analyses.

Exclusion Criteria

We excluded the following types of articles.

- Meeting abstracts, press releases, theses, nonsystematic review articles, articles reporting on studies that are within timeframes searched within meta-analyses and systematic reviews, and articles that could not be retrieved in English

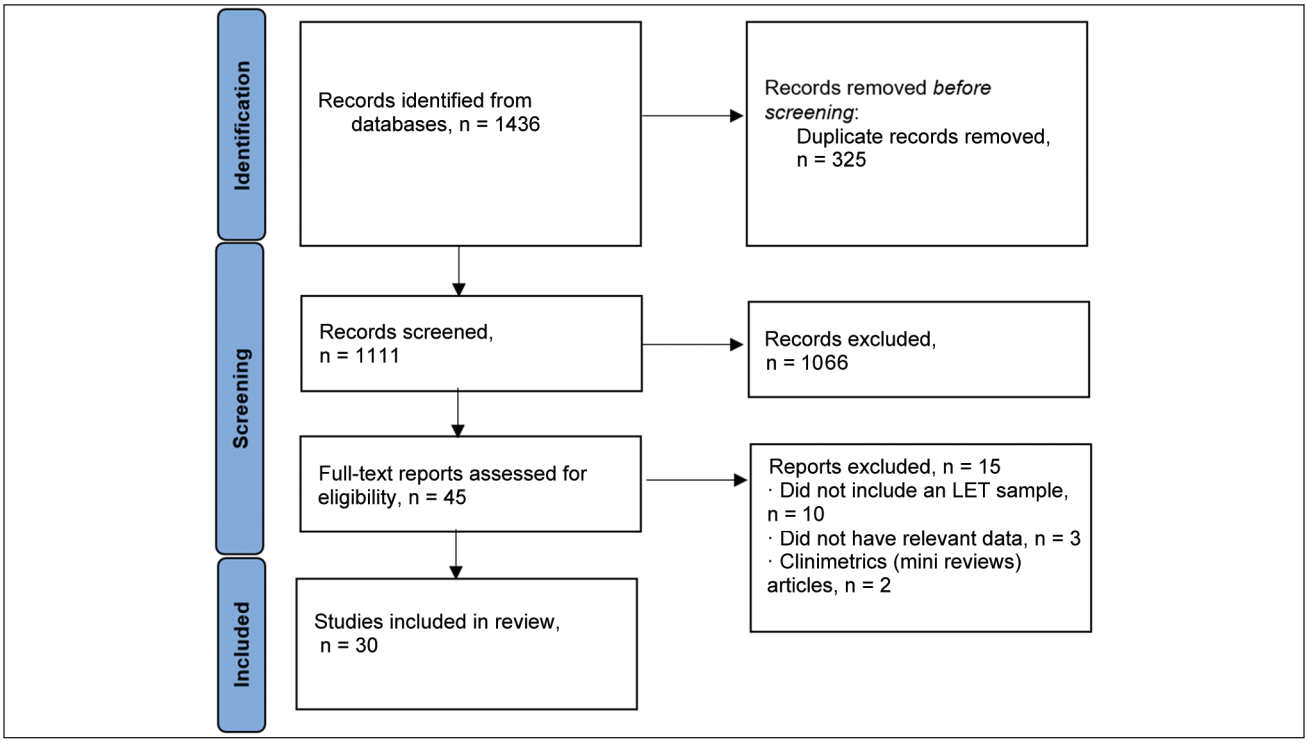
We excluded articles reporting on the following topics.

- Cervical radiculopathy, primary peripheral nerve entrapment including radial tunnel syndrome and posterior interosseous syndrome, and joint pathology including plica syndrome, radiocapitellar chondromalacia, and posterolateral rotatory instability as causes of lateral elbow pain
- Topics outside the scope of physical therapist practice including but not limited to pharmacological and surgical interventions unless directly compared to conservative physical therapy management

APPENDIX C

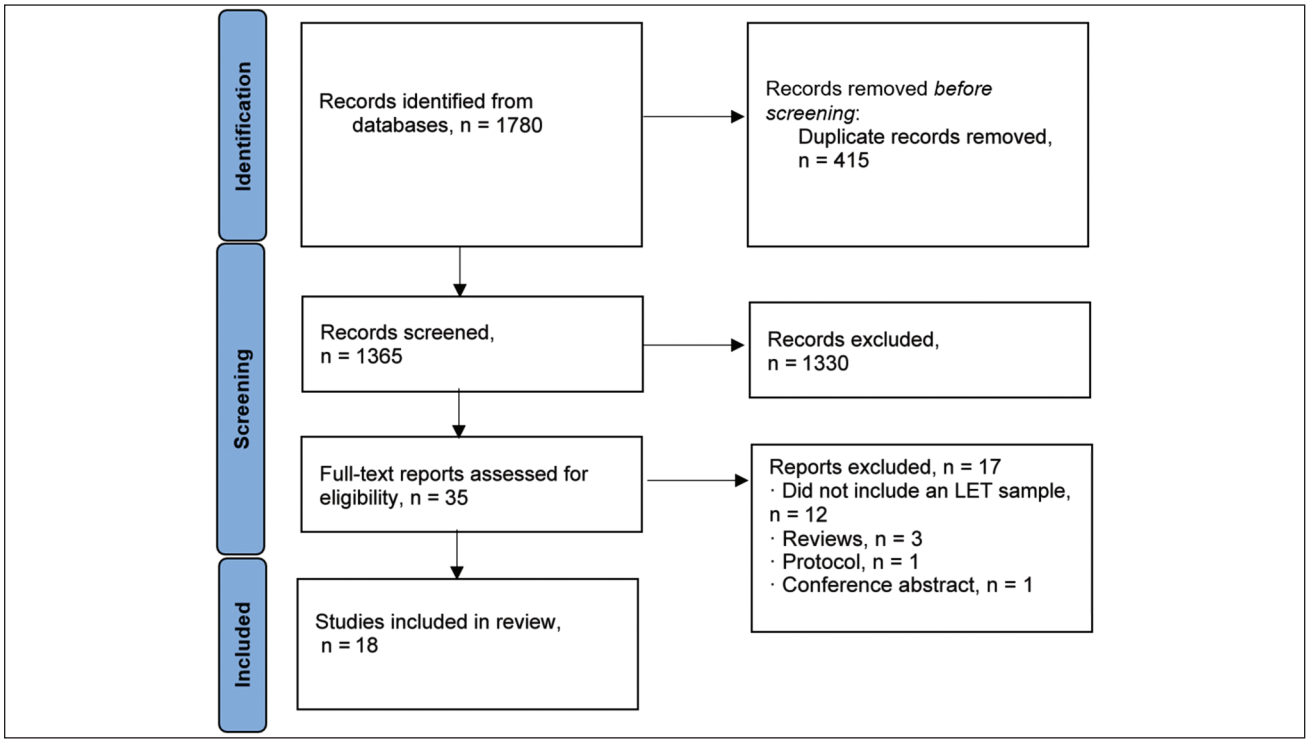
FLOWCHART OF ARTICLES

1. Self-report Measures



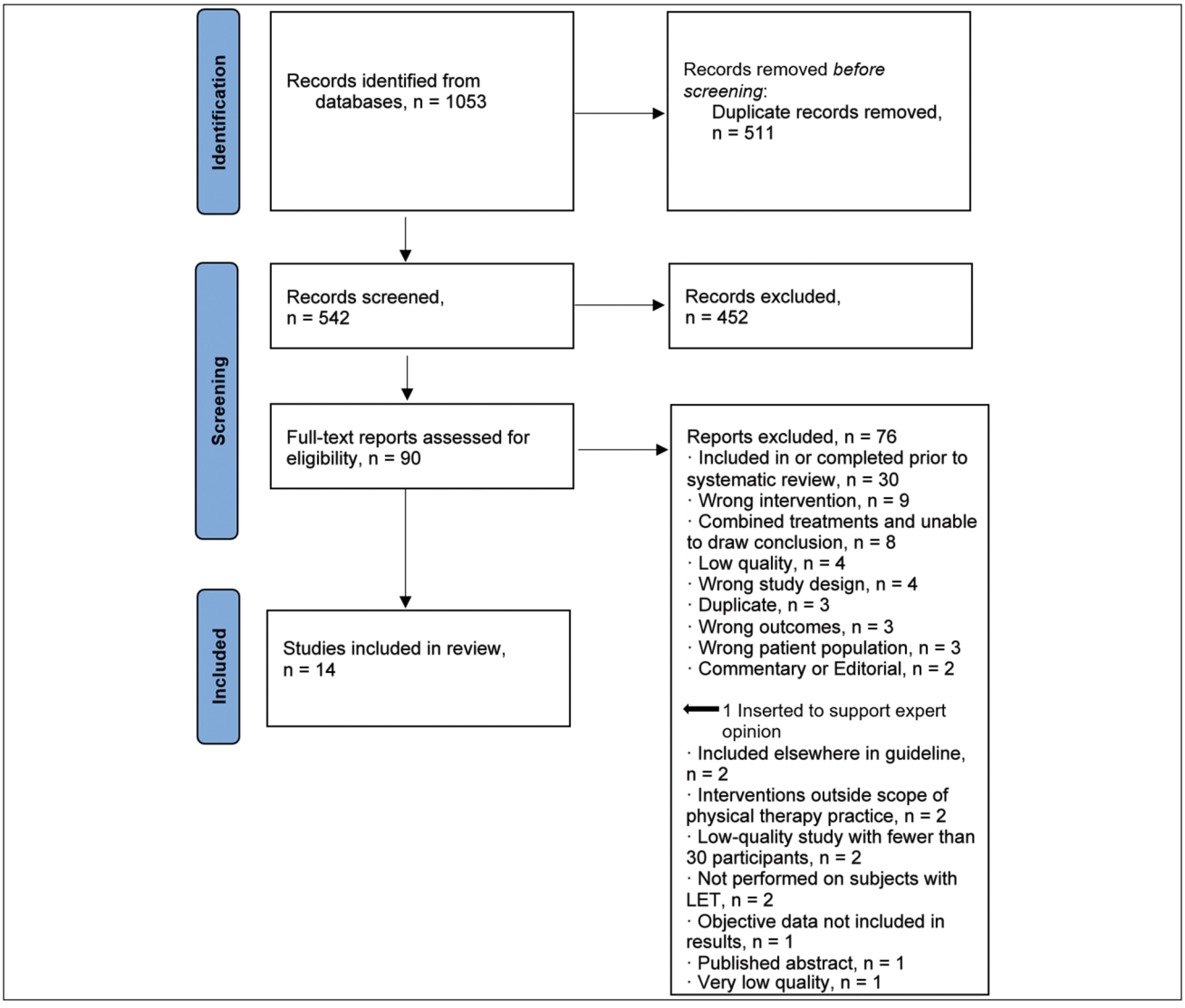
APPENDIX C (CONTINUED)

2. Clinician-Based and Performance-Based Measures



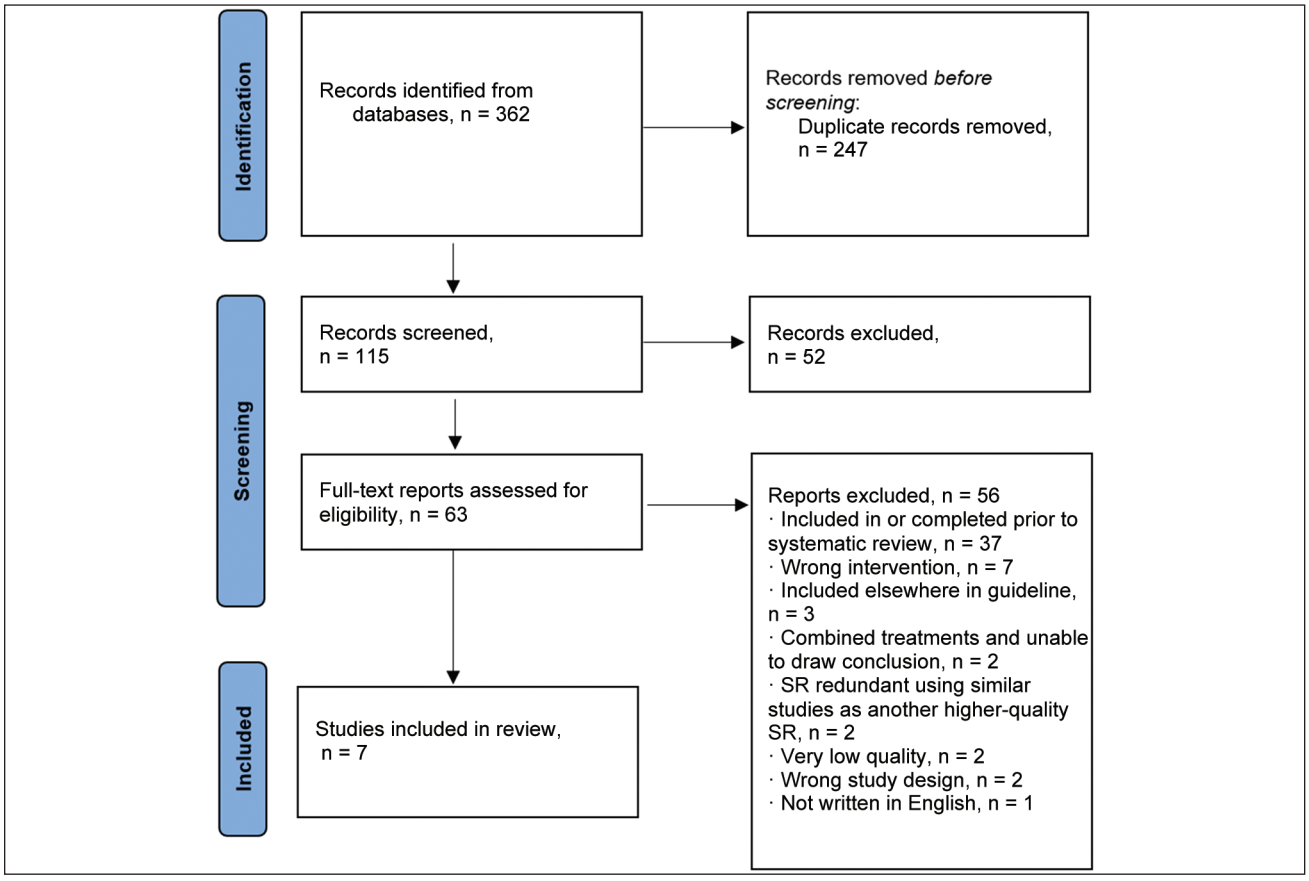
APPENDIX C (CONTINUED)

3. Exercise



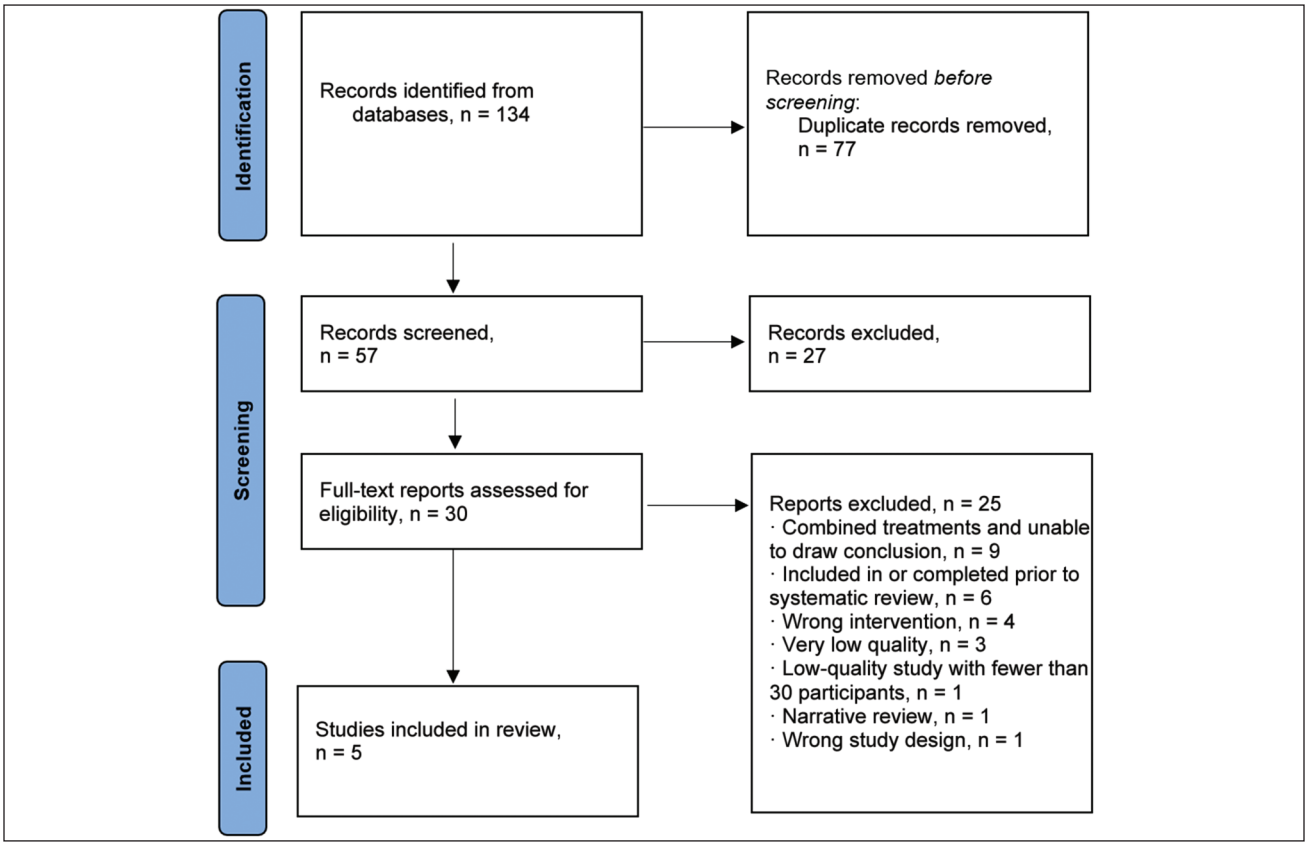
APPENDIX C (CONTINUED)

4. Manual Therapy: Joint Mobilizations



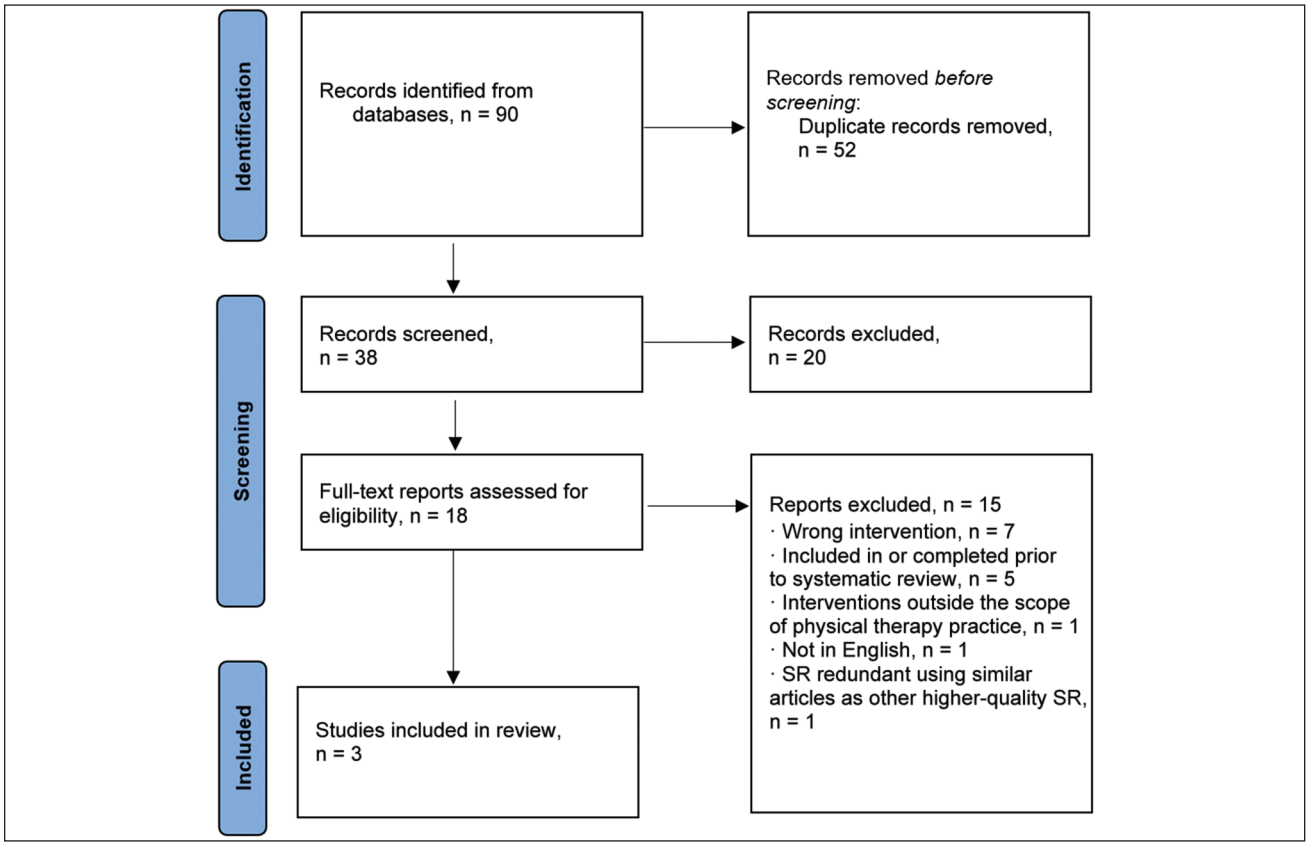
APPENDIX C (CONTINUED)

5. Manual Therapy: Soft Tissue Mobilizations



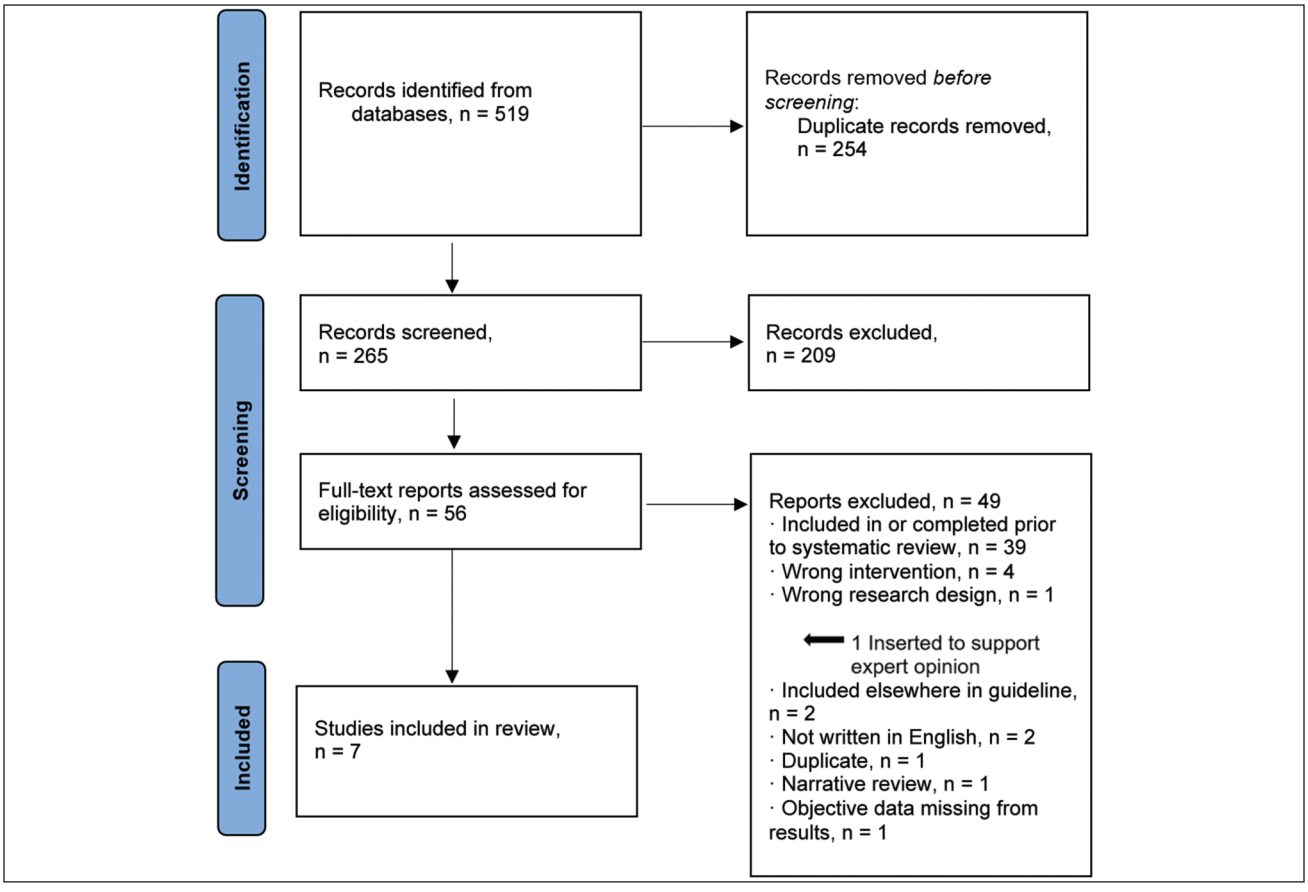
APPENDIX C (CONTINUED)

6. Dry Needling



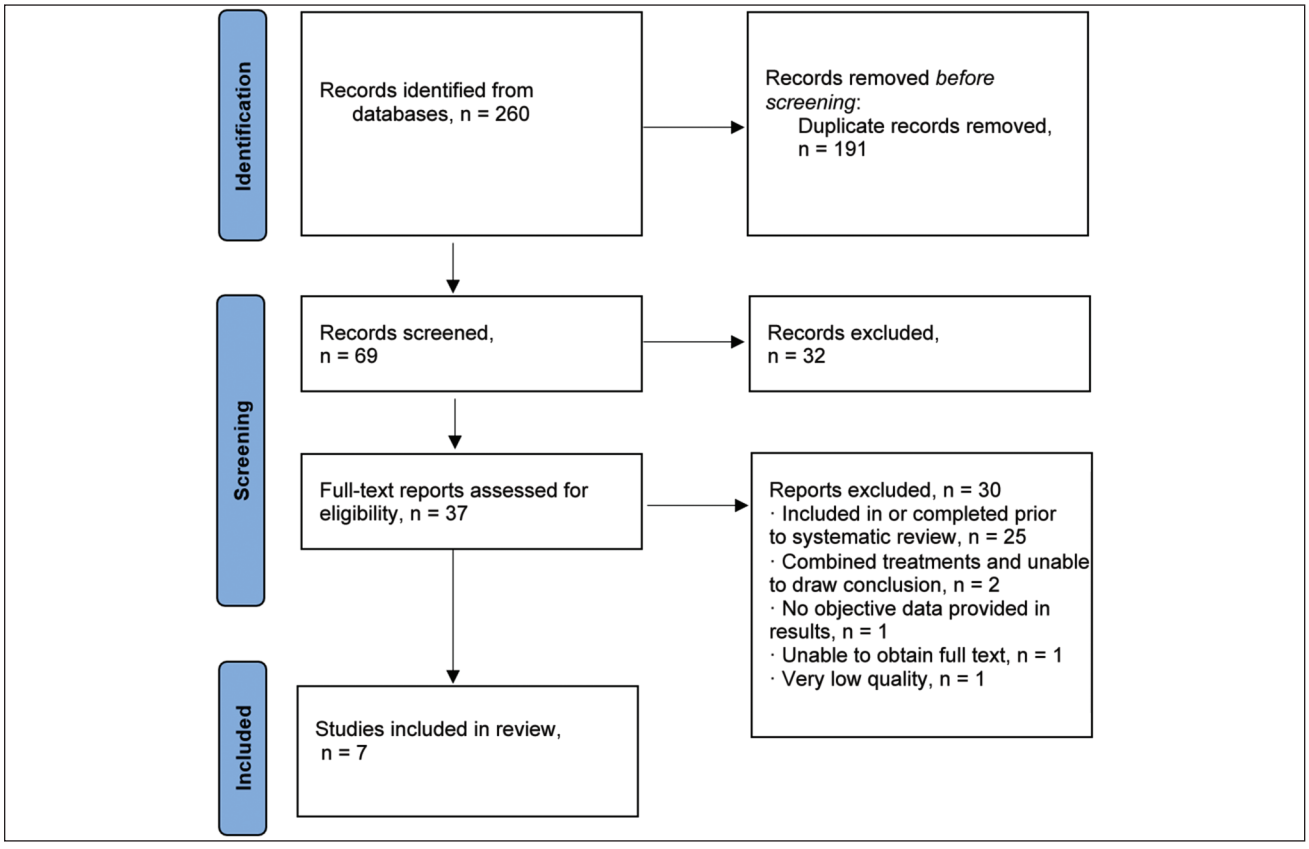
APPENDIX C (CONTINUED)

7. Orthoses



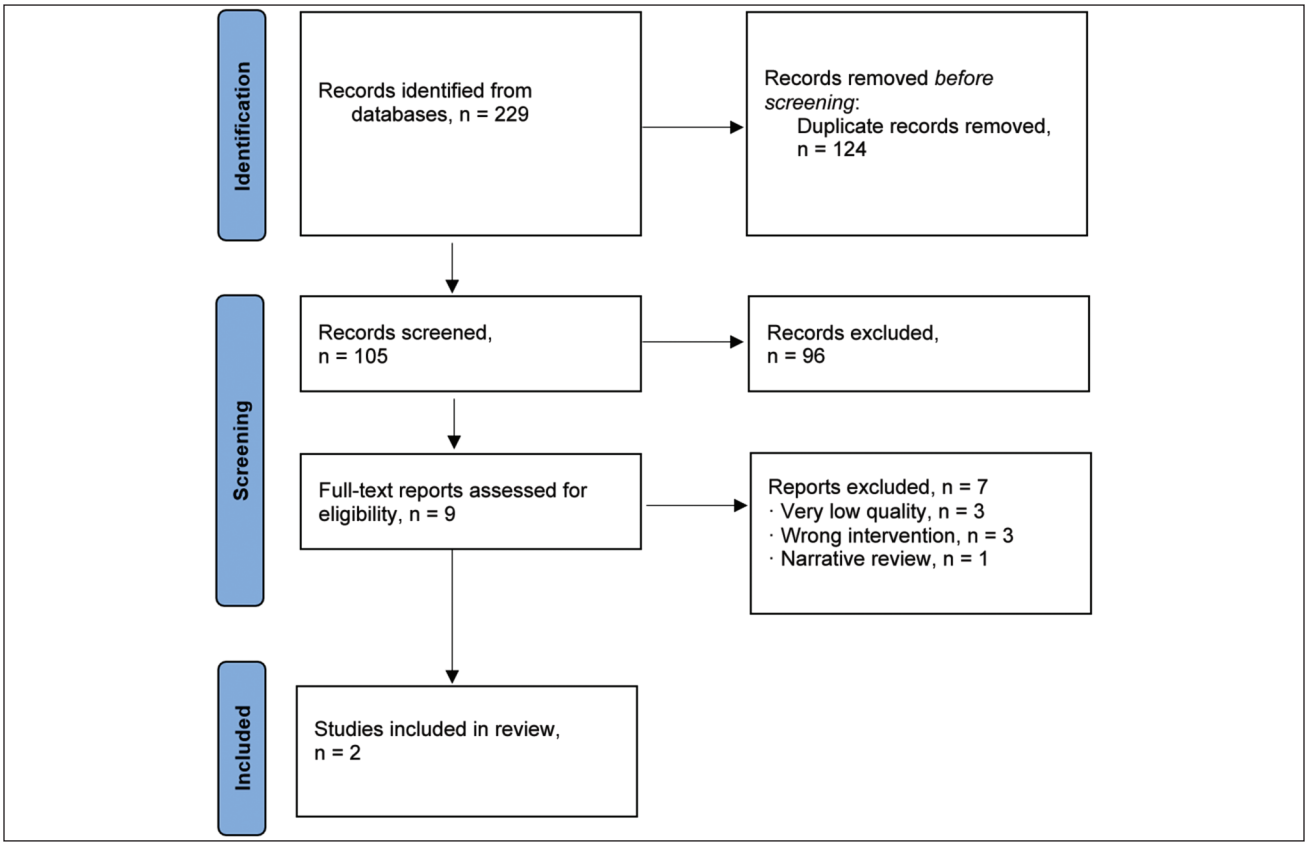
APPENDIX C (CONTINUED)

8. Taping



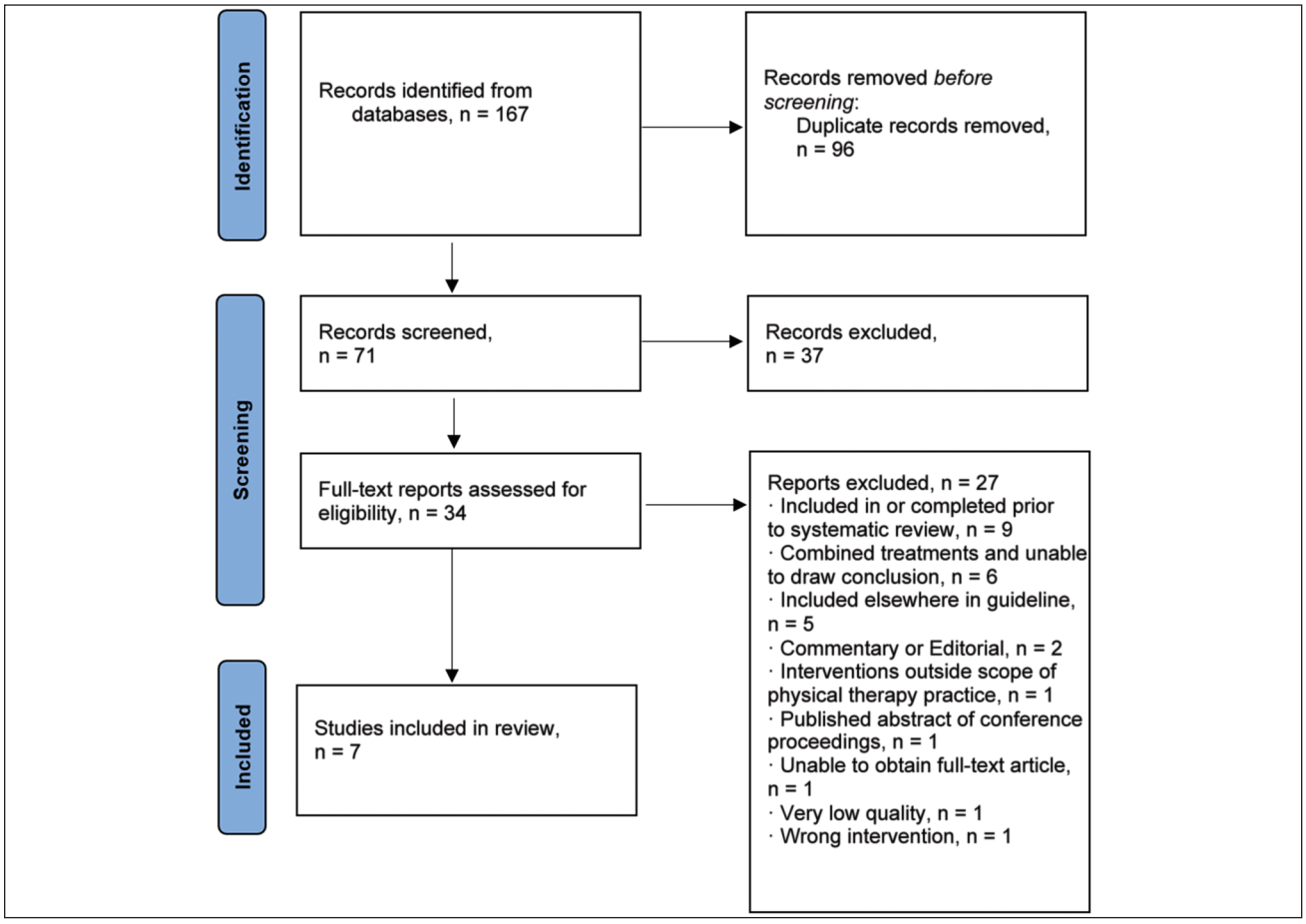
APPENDIX C (CONTINUED)

9. Thermal Modalities



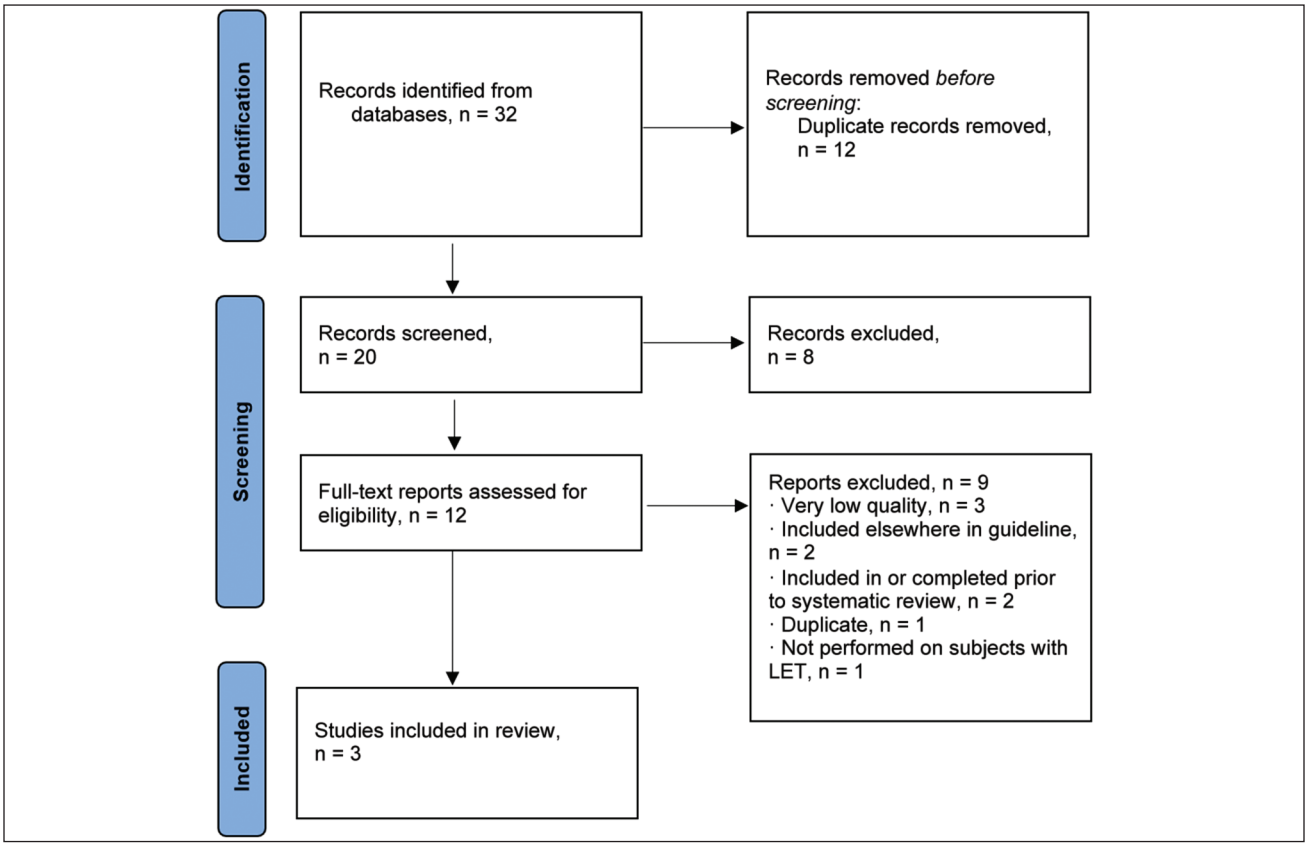
APPENDIX C (CONTINUED)

10. Ultrasound



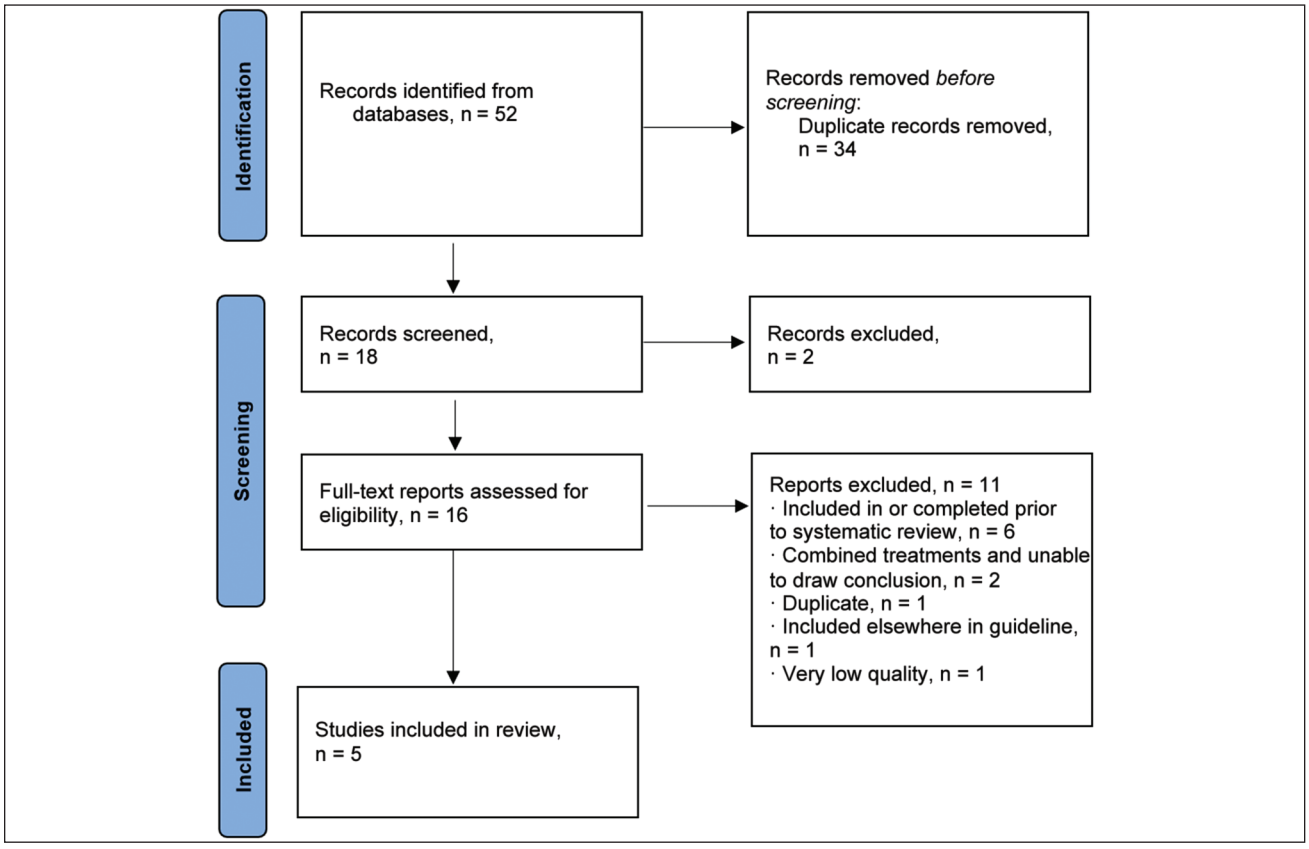
APPENDIX C (CONTINUED)

11. Phonophoresis



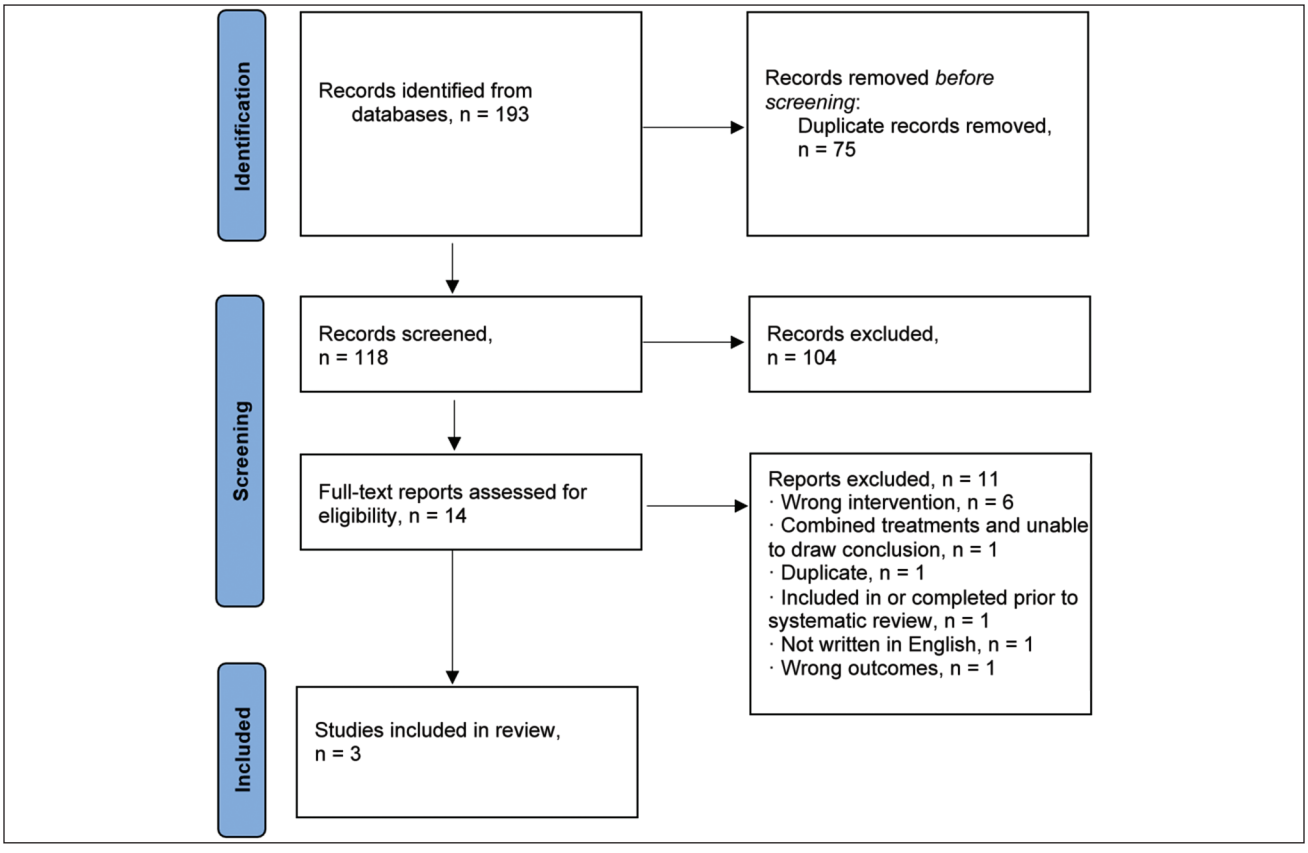
APPENDIX C (CONTINUED)

12. Iontophoresis



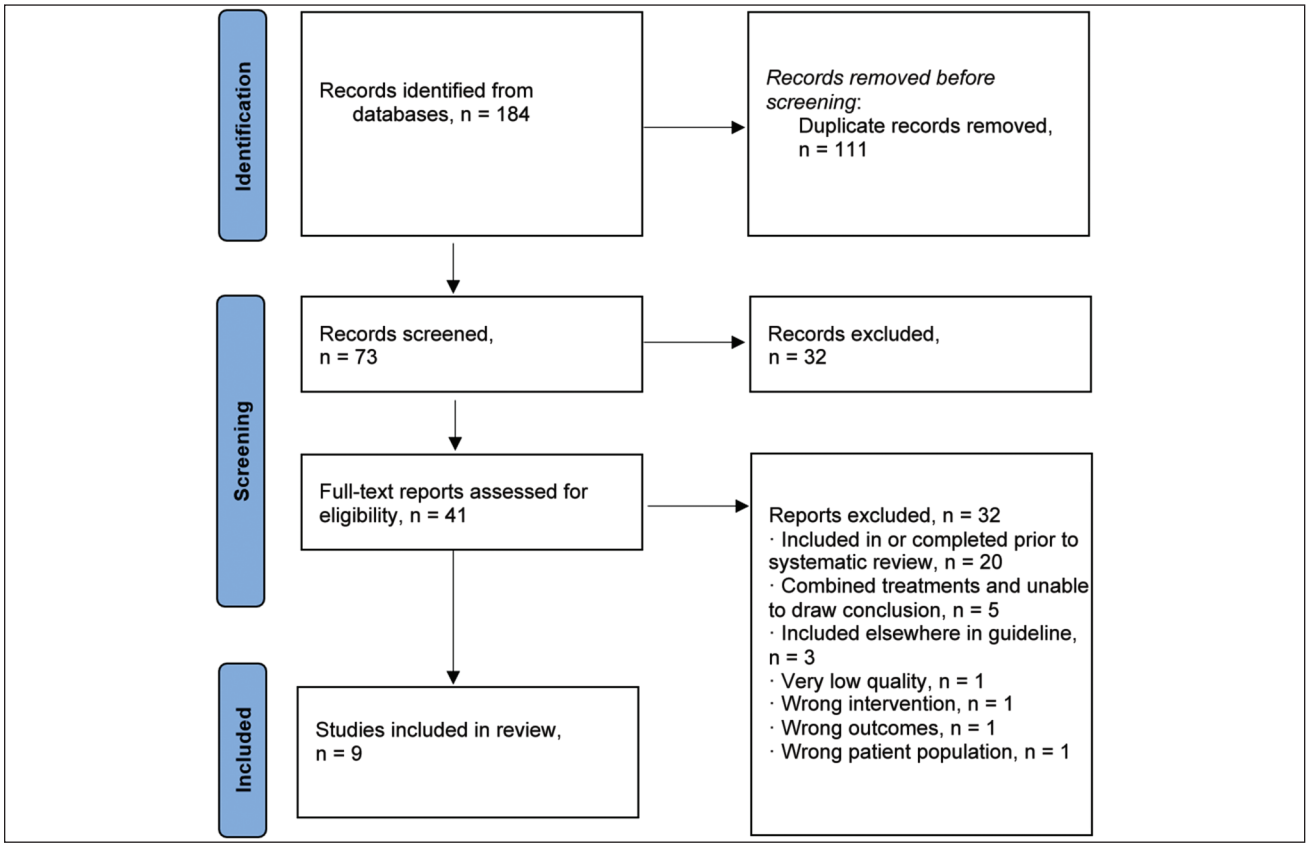
APPENDIX C (CONTINUED)

13. TENS



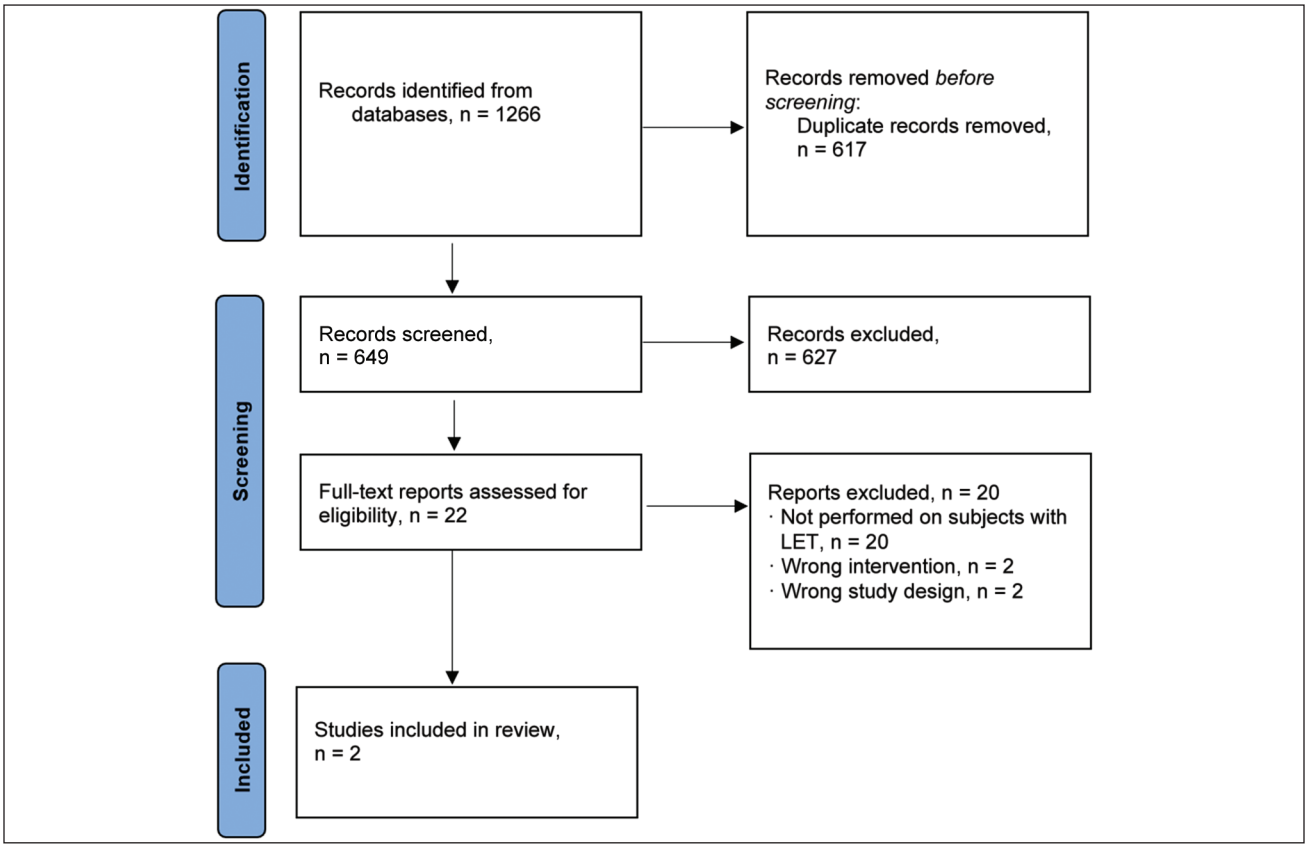
APPENDIX C (CONTINUED)

14. Laser



APPENDIX C (CONTINUED)

15. Ergonomics



From: Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ.* 2021;372:n71. https://doi.org/10.1136/bmj.n71

For more information, visit http://www.prisma-statement.org/.

APPENDIX D

LEVELS OF EVIDENCE TABLE[a]

Level	Intervention/ Prevention	Pathoanatomic/Risk/Clinical Course/ Prognosis/Differential Diagnosis	Diagnosis/Diagnostic Accuracy	Prevalence of Condition/ Disorder	Exam/Outcomes
I	Systematic review of high-quality RCTs High-quality RCT[b]	Systematic review of prospective cohort studies High-quality prospective cohort study[c]	Systematic review of high-quality diagnostic studies High-quality diagnostic study[d] with validation	Systematic review, high-quality cross-sectional studies High-quality cross-sectional study[e]	Systematic review of prospective cohort studies High-quality prospective cohort study
II	Systematic review of high-quality cohort studies High-quality cohort study[c] Outcomes study or ecological study Lower-quality RCT[f]	Systematic review of retrospective cohort study Lower-quality prospective cohort study High-quality retrospective cohort study Consecutive cohort Outcomes study or ecological study	Systematic review of exploratory diagnostic studies or consecutive cohort studies High-quality exploratory diagnostic studies Consecutive retrospective cohort	Systematic review of studies that allows relevant estimate Lower-quality cross-sectional study	Systematic review of lower-quality prospective cohort studies Lower-quality prospective cohort study
III	Systematic reviews of case-control studies High-quality case-control study Lower-quality cohort study	Lower-quality retrospective cohort study High-quality cross-sectional study Case-control study	Lower-quality exploratory diagnostic studies Nonconsecutive retrospective cohort	Local nonrandom study	High-quality cross-sectional study
IV	Case series	Case series	Case-control study		Lower-quality cross-sectional study
V	Expert opinion	Expert opinion	Expert opinion	Expert opinion	Expert opinion

Abbreviation: RCT, randomized clinical trial.

[a]*Adapted from the Center for Evidence-based Medicine 2009 levels of evidence.*[216] *See also* **APPENDIX E.**

[b]*High quality includes RCTs with greater than 80% follow-up, blinding, and appropriate randomization procedures.*

[c]*High-quality cohort study includes greater than 80% follow-up.*

[d]*High-quality diagnostic study includes consistently applied reference standard and blinding.*

[e]*High-quality prevalence study is a cross-sectional study that uses a local and current random sample or censuses*

[f]*Weaker diagnostic criteria and reference standards, improper randomization, no blinding, and less than 80% follow-up may add bias and threats to validity.*

APPENDIX E

PROCEDURES FOR ASSIGNING LEVELS OF EVIDENCE

- Level of evidence is assigned based on the study design using the Levels of Evidence table (**APPENDIX D**), assuming high quality (eg, for intervention, the randomized clinical trial starts at level I).
- Study quality is assessed using the critical appraisal tool, and the study is assigned 1 of 4 overall quality ratings based on the critical appraisal results.
- Level of evidence assignment is adjusted based on the overall quality rating:
  - High quality (high confidence in the estimate/results): the study remains at assigned level of evidence (eg, if the randomized clinical trial is rated high quality, its final assignment is level I). High quality should include the following:
    - a randomized clinical trial with greater than 80% follow-up, blinding, and appropriate randomization procedures;
    - a cohort study including greater than 80% follow-up;
    - a diagnostic study including consistently applied reference standard and blinding; and
    - a prevalence study that is a cross-sectional study which uses a local and current random sample or censuses.
  - Acceptable quality: the study does not meet requirements for high quality and weaknesses limit the confidence in the accuracy of the estimate—downgrade 1 level (based on critical appraisal results).
  - Low quality: the study has significant limitations that substantially limit confidence in the estimate—downgrade 2 levels (based on critical appraisal results).
  - Unacceptable quality: serious limitations—exclude from consideration in the guideline (based on critical appraisal results).

APPENDIX E (CONTINUED)

Lateral Elbow Tendinopathy Outcome Measures Quality Appraisals

Quality of studies included in the systematic review of outcome measures

	Item Evaluation Score for Each Criterion on the MacDermid Quality Assessment Tool (Min = 0; Max = 2)														
Study	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total Score**	**Quality Score (%)**	**Level of Evidence**
Poltawski and Watson (2011)	2	2	2	2	1	2	2	2	2	2	2	2	23	95.83	I
Leung et al (2004)	2	2	1	2	1	2	2	2	2	2	2	1	21	87.50	I
Overend et al (1999)	2	1	1	2	1	2	2	2	2	2	2	2	21	87.50	I
Cacchio et al (2012)	1	2	1	2	1	2	2	2	2	2	2	1	20	83.33	I
Blanchette and Normand (2010)	2	2	2	2	0	1	2	2	2	2	2	1	20	83.33	I
Rompe et al (2007)	2	2	2	2	1	0	2	2	2	2	1	2	20	83.33	I
Van Ark et al (2014)	2	2	0	2	0	2	2	2	2	2	2	1	19	79.16	I
Chung and Wiley (2010)	2	2	1	0	0	2	2	2	2	2	2	2	19	79.16	I
Altan et al (2010)	1	2	1	2	1	2	2	2	2	2	1	1	19	79.16	I
Kaux et al (2016)	1	2	1	2	1	2	1	0	2	2	2	2	18	75	I
Stasinopoulos et al (2015)	1	2	0	1	1	2	2	2	2	2	2	1	18	75	I
Nilsson et al (2008)	1	1	0	2	1	2	2	2	2	2	1	1	17	70.83	I
Newcomer et al (2005)	1	2	2	2	0	2	2	2	2	2	1	1	17	70.83	I
Alizadehkhaiyat et al (2007)	2	2	0	0	0	n/a	2	2	2	2	0	1	13	54.16	II

APPENDIX E (CONTINUED)

Lateral Elbow Tendinopathy Appraisal Grid Interventions

PEDro

	PEDro Scores[a]											
Study	**1[b]**	**2[c]**	**3[d]**	**4[e]**	**5[f]**	**6[g]**	**7[h]**	**8[i]**	**9[j]**	**10[k]**	**11[l]**	**Total**
Agostinucci et al (2012)	1	1	0	0	0	0	0	1	1	1	0	4
Akbar et al (2021)	1	1	1	1	0	0	0	1	0	1	1	6
Baktir et al (2019)	1	1	1	0	0	1	1	0	1	1	1	7
Blanchett and Normand (2011)	1	1	1	1	0	0	0	1	1	1	1	7
Chesterton et al (2013)	1	1	1	1	0	0	1	0	1	1	1	7
Coombes et al (2016)	1	1	1	0	0	0	1	0	1	1	1	6
da Luz et al (2019)	1	1	1	0	1	0	1	1	0	1	1	7
Day et al (2021)	0	1	0	1	1	0	0	1	0	1	1	6
Hüseyin Ünver et al (2021)	1	1	1	1	1	0	1	0	0	1	1	7
Kaydok et al (2020)	1	1	1	1	1	0	1	1	0	1	1	8
Lizis (2015)	1	1	0	1	0	0	0	1	1	1	1	6
Macedo (2015)	1	1	0	0	0	0	0	1	1	1	1	5
Mansiz-Kaplan et al (2021)	0	1	0	1	0	0	1	1	0	1	1	6
Martínez-Beltrán et al (2020)	1	1	0	1	1	0	0	1	1	1	1	7
Mostafaee et al (2020)	1	1	1	1	0	0	1	1	1	1	1	8
Nagrale et al (2009)	1	1	0	1	0	0	1	1	1	1	1	7
Özmen et al (2021)	1	1	0	1	0	0	0	1	1	1	1	6
Reyhan et al (2019)	1	1	1	1	0	0	0	1	1	1	1	7
Rodríguez-Huguet et al (2020)	1	1	1	1	0	1	0	1	1	1	1	8
Sethi and Noohu (2018)	1	1	0	1	0	0	0	0	1	1	1	5
Sevier and Stegink-Jansen (2015)	1	1	0	1	0	0	1	0	1	1	1	6
Tezel et al (2020)	1	1	0	1	0	0	1	0	0	1	1	5
Tran et al (2021)	1	1	1	1	0	0	0	1	1	1	1	7
Uygur et al (2021)	1	1	1	1	0	0	1	1	1	1	1	8
Vuvan et al (2020)	1	1	1	1	0	0	1	1	1	1	1	8
Yalvaç et al (2018)	1	1	1	1	1	0	0	1	0	1	1	7
Yi et al (2018)	1	1	1	1	0	0	1	0	0	1	0	5
Zunke et al (2020)	1	1	0	1	0	0	0	1	1	0	1	5

[a]*Scoring: 1 = criteria is present, 0 = criteria not present.*
[b]*Eligibility criteria were specified.*
[c]*Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received.*
[d]*Allocation was concealed.*
[e]*The groups were similar at baseline regarding the most important prognostic indicators.* [f]*There was blinding of all subjects.*
[g]*There was blinding of all therapists who administered the therapy.*
[h]*There was blinding of all assessors who measured at least one key outcome.* [i]*Measures of at least one outcome were obtained from more than 85% of the subjects initially allocated to groups.*
[j]*All subjects for whom outcomes measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analyzed by "intention to treat."*
[k]*The results of between-group statistical comparisons are reported for at least one key outcome.*
[l]*The study provides both point measures and measures of variability for at least one key outcome. Eligibility criteria item does not contribute to total score.*

APPENDIX E (CONTINUED)

AMSTAR

	AMSTAR Scores[a]											
Systematic Review	1[b]	2[c]	3[d]	4[e]	5[f]	6[g]	7[h]	8[i]	9[j]	10[k]	11[l]	Score
Bisset et al (2005)	1	1	1	0	0	1	1	1	1	0	0	7
Bisset et al (2011)	1	1	1	0	0	1	1	1	1	0	0	7
Borkholder et al (2004)	1	1	1	0	0	1	1	1	1	0	0	7
Chang et al (2010)	1	1	1	0	0	1	1	1	0	0	0	6
Chen and Baker (2021)	1	0	1	0	0	1	1	1	1	1	1	8
Cullinane et al (2014)	1	1	1	0	0	1	1	1	0	0	0	6
Dick et al (2011)	1	1	1	0	0	1	1	1	0	0	0	6
Dingemanse et al (2013)	1	1	1	0	0	0	1	1	0	0	0	5
George et al (2019)	1	0	1	1	0	1	1	1	1	1	1	9
Healy et al (2018)	1	1	1	0	0	0	1	1	0	0	0	5
Heales et al (2020)	1	1	1	0	0	1	1	1	1	1	1	9
Herd and Meserve (2008)	1	0	1	0	0	1	1	1	0	0	0	5
Hoogvliet et al (2013)	1	1	1	0	0	0	1	1	1	0	0	6
Karanasios et al (2021)	1	1	1	1	0	1	1	0	1	1	1	9
Kohia et al (2008)	1	1	1	0	0	1	1	1	0	0	0	6
Laimi et al (2018)	1	1	1	0	0	1	1	1	0	0	0	6
Lian et al (2019)	1	1	1	0	0	1	0	1	1	1	0	7
Loew et al (2014)	1	1	1	0	1	1	1	1	1	1	0	9
Lucado et al (2018)	1	0	1	0	1	1	1	1	1	1	0	8
Navarro-Santana et al (2020)	1	1	1	1	0	0	1	1	1	1	0	8
Olaussen et al (2013)	1	1	1	1	1	1	1	1	1	1	0	10
Raman et al (2012)	1	1	1	0	0	1	1	1	0	0	0	6
Shahabi et al (2020)	1	1	1	1	0	1	1	1	1	0	0	8
Sims et al (2014)	1	1	1	0	0	1	1	1	0	0	0	6
Tumilty et al (2010)	1	1	1	0	0	1	1	1	1	0	0	7
Yoon et al (2021)	1	1	1	1	1	0	1	1	1	1	1	10
Zhong et al (2020)	0	1	1	0	0	1	1	1	1	1	0	7

[a]*Scoring: 1 = criteria is present, 0 = criteria not present.*
[b]*Was an a priori design provided?*
[c]*Was there duplicate study selection and data extraction?*
[d]*Was a comprehensive literature search performed?*
[e]*Was the status of publication (ie, grey literature) used as an inclusion criterion?*
[f]*Was the list of included and excluded studies provided?*
[g]*Were the characteristics of the included studies provided?*
[h]*Was the scientific quality of the included studies assessed and documented?*
[i]*Was the scientific quality of the included studies used appropriately in formulating conclusions?*
[j]*Were the methods used to combine study findings appropriate?*
[k]*Was the likelihood of publication bias assessed?*
[l]*Was the conflict of interest stated?*

APPENDIX E (CONTINUED)

EVIDENCE TABLE

Evidence Table: Exercise

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Vuvan et al (2020)	RCT	Level of evidence: I PEDro score: 8/10	Exercise group received advice to complete an unsupervised program of isometric exercise of the wrist extensors at home for 8 wk. The program consisted of daily isometric wrist extension exercise, performed using a container of water with a handle as resistance.	Forty patients meeting the following inclusion criteria: aged 18 to 70 years; unilateral lateral elbow pain, ≥6-wk duration; average pain severity during the past week, ≥2 on an 11-point numerical rating scale (0 = no pain; 10 = worst pain imaginable); provoked by at least 2 of the following: gripping, palpation of the lateral epicondyle, stretching of forearm extensor muscles, resisted wrist extension, resisted second or third finger extension, and reduced PFGS	PRTEE, GROC, PFGS, pain (NPRS), and pressure thresholds	The unsupervised exercise group reported a decrease in worst pain (standardized mean difference (SMD, −0.80; 95% CI: −1.45, −0.14) and disability (SMD, −0.92; 95% CI: −1.58, −0.26), but not in perceived rating of change or PFGS when compared with wait and see at 8 wk. No serious adverse effects were reported. Unsupervised isometric wrist extensor exercise was effective in improving pain and disability, but not perceived rating of change and PFGS when compared with wait and see at 8 wk.

Table continues on next page.

APPENDIX E (CONTINUED)

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Yoon et al (2021)	Study review/ meta-analysis	Level of evidence: II AMSTAR score: 10/11	Six studies qualified for inclusion: (1) patient allocation was randomized, (2) the sample was composed of patients with LET, (3) the intervention was eccentric exercise, and (4) the study outcome was pain intensity, strength, or function. Studies were only included that evaluated effects of eccentric exercise (eccentric exercise + adjuvant therapy vs same adjuvant therapy) or (eccentric exercise vs other strengthening exercises. Exclusion: (1) The trial did not have an appropriate comparison group; (2) eccentric exercise was performed with other nonsurgical treatments and the effects of eccentric exercise could not be isolated; or (3) data on pain intensity, strength, or function were not sufficiently reported.	All included studies were determined to have high risk of bias as assessed by the Cochrane Risk to Bias Tool. All studies examined eccentric exercise alone to passive treatment (heat, ice, US, cross-friction massage), stretching, or concentric exercises. Treatment frequencies varied among studies.	Pain, muscle strength, function	A significant improvement in the VAS score after eccentric exercise (SMD, −0.63; 95% CI: −0.90, −0.36) relative to the VAS score in the comparison group was observed in the 4 studies that looked at VAS. Four studies reported outcomes of muscle strength: 3 studies with grip strength and 1 study with eccentric muscle strength. A significant improvement in muscle strength in the eccentric exercise group (SMD, 1.05; 95% CI: 0.78, 1.33) relative to the comparison group was observed. Sensitivity analysis, conducted by individually excluding the studies, also showed beneficial effects of eccentric exercise in pain reduction and muscle strength improvement in patients with LET. Three studies compared the effects of eccentric exercises with those of other strengthening exercises, such as concentric or isotonic exercise. There was a significant improvement in pain intensity after eccentric exercise (SMD, −0.30; 95% CI: −0.58, −0.02) relative to other exercises. Two of the studies that looked at eccentric, concentric, or isotonic exercise also evaluated muscle strength and there was no significant difference in muscle strength between the 2 groups (SMD, −0.09; 95% CI: −0.38, 0.20). Function was evaluated using the DASH results in 3 studies and the meta-analysis did not reveal any significant difference in functional improvement (SMD, −0.08; 95% CI: −0.35, 0.20) between the 2 groups.

Table continues on next page.

APPENDIX E (CONTINUED)

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Chen and Baker (2021)	Meta-analysis	Level of evidence: II AMSTAR : 8/11	Eight moderate quality (average PEDro = 6) articles RCT and quasi-experimental trials published through December 2018 with a total of 504 patients that included eccentric strengthening of the wrist extensors as part of treatment protocol or compared eccentric strengthening with other forms of strengthening.	Adult patients with lateral elbow tendinopathy symptoms longer than 3 weeks.	Pain (VAS), grip strength, function (studies used various questionnaires to measure function)	When comparing eccentric strengthening of the wrist extensors to other forms of strengthening and pain-relieving modalities, there were significant large effect size in reducing pain and improving function in the short term. A significant improvement in the VAS score after eccentric exercise (SMD, −0.63; 95% CI: −0.90, −0.36) relative to the comparison group was observed in the 4 studies that looked at VAS. Four studies reported outcomes of muscle strength: 3 studies with grip strength and 1 study with eccentric muscle strength. A significant improvement in muscle strength in the eccentric exercise group (SMD, 1.05; 95% CI: 0.78, 1.33) relative to the comparison group was observed. Eccentric exercise combined with adjuvant therapy showed beneficial effects regarding pain reduction and muscle strength improvement. Comparison between eccentric exercise and other exercises showed positive effects of eccentric exercise regarding pain reduction; however, the differences in muscle strength and function between the groups were not significant.

Table continues on next page.

APPENDIX E (CONTINUED)

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Karanasios et al (2020)	Meta-analysis	Level of evidence: II AMSTAR score: 9/11	Thirty low- to very low-quality RCTs published through November 2019 assessing the effectiveness of wrist exercise alone or as an additive intervention compared with passive interventions, wait and see, or injections inpatients with LET.	Two thousand one hundred twenty-three participants from 30 RCTs with LET tendinopathy	PRTEE, Tennis Elbow Function Scale, Nirschl/Pettrone pain score, DASH, Pain-free function questionnaire, GROC, pain, PFGS	In the long term, exercise was better than corticosteroid injection in improving PFGS (MD, 12.15 kg; 95% CI: 1.69, 22.6), pain reduction (SMD, −0.56; 95% CI: −0.78, −0.34), and disability (SMD, −0.64; 95% CI: −0.86, −0.42). Similar observations were noted for the short term and the midterm, except for short-term pain reduction. When exercise was compared to a wait-and-see approach, only short-term pain reduction (SMD, −0.33; 95% CI: −0.60, −0.05) and long-term elbow disability (SMD, −0.27; 95% CI: −0.47, −0.06) were statistically significant, in favor of exercise. Low to very low evidence suggests exercise of the wrist musculature is effective compared with passive interventions with or without invasive treatment in LET, but the effect is small.
Hoogvliet et al (2013)	Systematic review	Level of evidence: II AMSTAR score: 6/11	Studies published through February 2010 that included the evaluation of several therapeutic interventions: stretching, strengthening, concentric/eccentric exercises of the wrist, and manipulation of the cervical or thoracic spine, elbow or, wrist.	A total of 12 RCTs and 1 review up to February 2010 were included. Follow-up time frames of the included studies were up to 3 years.	Pain (VAS), function (DASH), grip strength. Data were not pooled due to the heterogeneity of the included studies; however, when available, authors reported percent change or mean differences between groups for individual studies in the systematic review.	Moderate evidence for the short-term effectiveness of stretching plus strengthening exercises of the wrist over US plus friction massage; for short- and midterm effectiveness of concentric and eccentric exercises as an adjunct to manipulation of the cervical and thoracic spine.

Table continues on next page.

APPENDIX E (CONTINUED)

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Raman et al (2012)	Systematic review	Level of evidence: II AMSTAR score: 6/11	Adults who were diagnosed with lateral epicondylitis and received one of the following exercise interventions of the wrist: isotonic exercises, exercises combined with conventional therapy, eccentric exercise alone, isometric exercises, or isokinetic exercises.	Eleven articles (12 studies) from Jan 1990 to December 2010 met inclusion criteria. Of the 12 studies, 9 addressed the effects of isotonic (eccentric/concentric) exercises, two studied the effect of isometric exercises, and one studied isokinetic exercises. The exercise programs ranged over a period of 4 to 52 weeks. Seven RCTs, 4 non-RCTs, and 1 cohort study were assessed as moderate to high quality.	VAS, DASH, Modified Nirschl/Pettrone score (16%), Mayo Elbow Performance score (8%), Patient-rated Forearm Evaluation (16%), Short Form-36 (8%), and the Global measure of improvement (8%). Range of motion and pain-free grip strength (no pooling of results conducted).	Patients with LET who perform isotonic, eccentric, concentric, isometric, or isokinetic exercises of the wrist show positive changes in pain, strength, and disability over time.
Bisset et al (2011)	Systematic review	Level of evidence: II AMSTAR score: 7/11	Adults who were diagnosed with tennis elbow with the following inclusion criteria; published systematic reviews of RCTs and RCTs in any language, at least single blinded, and containing >20 individuals of whom >80% were followed up.	2 systematic reviews, 1 RCT evaluating wrist exercise (eccentric, isotonic, isometric)	Pain, grip strength, function, global improvement, or patient satisfaction scale (no pooling of results conducted).	Low-quality evidence neither supports nor refutes the use of wrist exercises as an effective intervention for LET.
Day et al (2019)	Clinical commentary	Level of evidence: V	N/A	N/A	N/A	This commentary describes an evidence-based regional treatment algorithm for individuals with LET that was designed for an RCT protocol. The Dual Rehabilitation Program describes 2 matrices for exercise prescription and dosing for both the shoulder and distal arm. Exercise progression parameters are delineated into 3 phases. Phase 1 = Neuromuscular re-education; Phase 2 = Resistive with light to moderate loads/short lever arms; and Phase 3 = Resistive with moderate to heavy loads/long lever arms. Exercise progression is based off of individual symptoms and % MVIC. Time to progress varies among individuals with LET based on their symptom presentation.

Abbreviations: DASH, Disabilities of the Arm, Shoulder and Hand; GROC, Global Rating of Change; LET, lateral elbow tendinopathy; MD, mean difference; MVIC, maximum voluntary isometric contraction; NPRS, numeric pain-rating scale; PFGS, pain-free grip strength; PRTEE, Patient-Rated Tennis Elbow Evaluation; RCT, randomized clinical trial; SMD, standardized mean difference; US, ultrasound; VAS, visual analog scale.

APPENDIX E (CONTINUED)

Evidence Table: Multimodal Interventions

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Mostafaee et al (2020)	RCT	Level of evidence: I PEDro score: 8/10	Patients with LET were randomly allocated into 2 groups: shoulder and scapula muscle training plus conventional physical therapy, and conventional physical therapy	Forty-eight patients meeting the following inclusion criteria: between the ages 18 and 65, pain over the lateral humeral epicondyle with pain severity of at least 4 on a VAS for a minimum of 6 weeks, ability to complete questionnaires in Persian, and confirmed diagnosis.	Pain, PFGS, functional status	The program that combined multimodal physical therapy with shoulder and scapular muscle training was more effective in improving pain (MD, 2.20; 95% CI: 1.32, 3.09) and function using the PRTEE (MD, 21.25; 95% CI: 11.07, 31.43); and QuickDASH (MD, 15.36; 95% CI: 5.94, 24.78) when compared with multimodal physical therapy at 4-month follow-up, but there were no significant differences in PFGS.
Day et al (2021)	RCT	Level of evidence: II PEDro score: 6/10	Thirty-five adults clinically diagnosed with LET were randomly allocated into 2 groups: 19 randomized to local treatment (LT) group, 15 randomized to LT plus scapular muscular strengthening (SMS) group	The SMS group received education and treatment as the LT group treatment, plus SMS. The LT treatment algorithm included education, counterforce bracing, cryotherapy if needed for pain control, manual therapy, and therapeutic exercise local to the wrist, whereas the SMS treatment algorithm included LT and SMS.	PRTEE, GROC, grip strength, periscapular muscle strength measured at baseline and discharge from PT (4-6 weeks), 6- and 12-month follow-up	Significant main effect for time for the PRTEE measures of both pain and function. Both groups changed at the same rate, as there was no significant difference between groups. The initial change from evaluation to discharge was significant (mean = −10.96, SD = 8.7, $P<.05$). Following discharge, pain and functional gains were maintained, suggesting that the intervention had positive long-term effects in both groups. Significant main effect for time for the strength outcome measures. Although the mean differences in scapular muscle strength were greater in the LT+SMS group, there were no significant between-group differences for all 4 secondary outcome measures of strength. The average GROC for all participants improved at discharge (mean = 9.33, SD = 1.06), the 6-month follow-up (mean = 9.92, SD = 0.93), and the 1-year follow-up (mean = 10.15, SD = 1.00). There were no statistical differences between groups for any of the follow-ups ($P>.103$).

Table continues on next page.

APPENDIX E (CONTINUED)

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Cullinane et al (2014)	Systematic review	Level of evidence: II AMSTAR score: 6/11	RCTs or controlled clinical trials that included an eccentric exercise therapy group, either exclusively or as a part of a multimodal treatment. The search included studies up to February 2013.	The 12 low-quality studies involved 616 participants consisting of 336 females and 280 males. A total of 326 participants underwent eccentric exercise as part of their rehabilitation.	Pain, function, grip strength (no pooling of results conducted)	Eccentric exercises are most effective as part of a multimodal intervention program.
Olaussen et al (2013)	Systematic review	Level of evidence: II AMSTAR score: 10/11	The authors included studies published between 2009 and 2012, utilizing a randomized control trial design, used 1 validated patient-centered outcome, scored a 5 or greater on the PEDro, included patients with a clinical diagnosis of lateral epicondylalgia, and reported corticosteroid injections, exercise, education, or manual therapy as an intervention.	The included studies represented a total population of 1161 patients. Several studies had more than one treatment group, so the 11 included studies investigated 15 treatment groups relevant for this review. Most participants had a duration of LET of several weeks to months and only one stated a short duration. Studies utilizing electrotherapeutic modalities or splinting were excluded.	Relative risk (RR) or standardized mean difference (SMD) for overall improvement, pain, and grip strength at 4-12, 26, and 52 weeks of follow-up	Corticosteroid injection and manipulation with exercise gave a short-term benefit (4-12 weeks) in overall improvement compared with control with RR and 95% CI of 2.27 (1.04, 4.97) and 2.75 (2.09, 3.62), respectively. However, for the intermediate term (3-6 months), outcomes for individuals treated with corticosteroid injections were worse (0.66; 0.53, 0.81) while manipulation with exercise was not different from control (0.99; 0.75, 1.30). In the long term (greater than 6 months), both treatments showed no benefit over control. One study showed a short-term positive effect on pain (SMD, 4.45; 95% CI: 3.51, 5.40) and grip strength (SMD, 3.16; 95% CI: 2.40, 3.92) for eccentric exercises and stretching. Long-term follow-up also showed a positive effect on pain (SMD, 4.65; 95% CI: 3.68, 5.63) and grip strength (SMD, 3.65; 95% CI: 2.82, 4.47). At intermediate follow-up, the authors found an increase in pain and reduction in grip strength for the corticosteroid group. Manipulation and exercise versus no intervention showed beneficial effect at short-term follow-up. Moderate evidence was found for short-term and long-term effects of eccentric exercise and stretching versus no intervention.

Table continues on next page.

APPENDIX E (CONTINUED)

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Sethi and Noohu (2018)	RCT	Level of evidence: II PEDro score: 5/10	Chronic lateral epicondylalgia	Twenty-six patients: Group 1 received SMS along with conventional physical therapy and Group 2 received only conventional physical therapy. Conventional physical therapy consisted of pulsed US (20% duty cycle, 7.5 min, 1 MHz, 2 W/cm^2), ECRB stretching (6 reps, 30–45-s hold), and a progressive eccentric wrist extension strengthening program using resistance bands.	Pain (VAS), PFGS, functional outcome (PRTEE), scapular muscle strength, scapular positioning (LSST), and EMG activity were collected at baseline and 6 weeks	There was a statistically significant difference for time effect for all the outcome measures. The scapular muscle strengthening should be used along with the conventional physical therapy in individuals with chronic LE to improve pain, PFGS, functional outcome, muscle strength, scapular position, and muscle activity.
Coombes et al (2016)	RTC stratified by high and low pain scores	Level of evidence: II PEDro score: 6/10	Participants were randomly allocated into 1 of 4 groups: saline injection, corticosteroid injection, physical therapy plus saline, and physical therapy plus corticosteroid. All participants received 1 injection and standardized advice on resting for 10 days followed by a gradual return to activity. The participants allocated to physical therapy received a standard protocol of manual therapy at the elbow with gripping, concentric and eccentric wrist exercises, motor control retraining, and global upper extremity exercises.	Eligibility criteria included patients who were 18 years and older, pain more than 6 weeks, greater than 30 on the VAS, and 2 clinical signs of lateral epicondylalgia. A total of 154 participants were included in the study.	Quality-Adjusted Life Years (QALYs), a measure of quality of life and a "1 year cost to society, incremental costs, and cost to the individual analysis." Cost effectiveness (measure by the incremental cost/QALY ratio)	Physical therapy had greater initial costs but was the only intervention that resulted in significantly greater quality-of-life scores after 1 year. The probability of being more cost effective than placebo was 81% for physical therapy, 53% for corticosteroid, and 24% for the combination of corticosteroid and physical therapy.

Abbreviations: DASH, Disabilities of the Arm, Shoulder and Hand; ECRB, extensor carpi radialis brevis; EMG, electromyography; GROC, Global Rating of Change; LET: lateral elbow tendinopathy; LSST, lateral scapular slide test; MD, mean difference; PRTEE, Patient-Rated Tennis Elbow Evaluation; RCT, randomized clinical trial; US, ultrasound; VAS, visual analog scale.

APPENDIX E (CONTINUED)

Evidence Table: Manual Therapy Joint Mobilizations/Manipulations

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Lucado et al (2019)	Systematic review and meta-analysis	Level of evidence: II AMSTAR score: 8/11	Studies examining individuals 18 years and older clinically diagnosed with LET treated with joint mobilizations/manipulations to the elbow or related areas in the upper quarter.	Twenty studies included; seven were appropriate for meta-analysis.	Pain, grip strength, and functional outcomes	There is compelling evidence that joint mobilizations have a positive effect on both pain and/or functional grip scores across all time frames compared to control groups in the management of LET. Only 7 trials were appropriate for the meta-analysis. The MWM technique to the elbow demonstrated a moderate positive mean effect (SMD, 0.43; 95% CI: 0.15, 0.71) on pain and a moderate positive effect on PFGS (SMD, 0.31; 95% CI: 0.11, 0.51). One study reported a moderate positive effect (SMD, 0.77; 95% CI: 0.81, 1.37) of MWM on pain and disability compared to groups receiving placebo and/or other nonsurgical interventions as measured by the PRTEE in the short term. Mill's manipulation technique to the elbow demonstrated a moderate positive effect (SMD, 0.47; 95% CI: 0.11, 0.82) on pain (VAS), but no appreciable effect (SMD, 0.01; 95% CI: −0.27, 0.26) on PFGS. Regional mobilization demonstrated effectiveness over control groups in all outcomes.
Hoogvliet et al (2013)	Systematic review	Level of evidence: II AMSTAR score: 6/11	Studies that included the evaluation of several therapeutic interventions: stretching, strengthening, concentric/eccentric exercises, and manipulation of the cervical or thoracic spine, elbow, or wrist.	A total of 12 RCTS and 1 review were included.	Pain, function, grip strength with not enough homogeneity to pool data	Moderate evidence for short- and midterm effectiveness on PFGS of manipulation of the cervical and thoracic spine as an adjunct therapy to exercise at 6 weeks (MD, 14.6 kg; 95% CI: 9.3, 19.9) and at 6 months (MD, 19.6 kg; 95% CI: 1.6, 37.6) compared with local treatment only. Limited evidence suggests that the use of a 2.5 N force while performing MWM technique is more effective in increasing PFGS immediately when compared to using a force of 1.2 or 1.9 N.

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APPENDIX E (CONTINUED)

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Bisset (2011)	Systematic review	Level of evidence: II AMSTAR score: 7/11	Adults who were diagnosed with tennis elbow with the following inclusion criteria; published systematic reviews of RCTs and RCTs in any language, at least single blinded, and containing >20 individuals of whom >80% were followed up.	Two survey reviews, 1 RCT evaluating joint mobilizations or manipulations	Pain, grip strength, function, global improvement, or patient satisfaction scale (no pooling of results conducted)	Low-quality evidence supports manipulation of the elbow for improving PFGS immediately compared with a sham manipulation (SMD, 1.28; 95% CI: 0.84, 1.73). Low-quality evidence also supports elbow manipulation when combined with US for reducing pain at 3 weeks ($P<.01$) and at 12 weeks ($P<.05$).
Herd and Meserve (2008)	Systematic review	Level of evidence: II AMSTAR score: 5/11	Studies exhibited the following: experimental design, comparison between at least 2 treatment conditions, subjects with clinical diagnosis of LE, use of at least one patient-centered outcome, and inclusion of manipulative treatment in at least one group.	Thirteen studies were deemed as having met inclusion criteria. Specific mobilizations that are used included mobilization with or without movement at the elbow, cervical spine mobilizations, Cyriax therapy, and neural glides.	The 2 most frequently used outcome measures were PFGS and patient-reported rating of change or global improvement.	Results of this review support the use of MWM in providing immediate and long-term benefits. Good short-term results were demonstrated with cervical manipulative therapy. No specific summary data were provided.
Akbar et al (2021)	RCT	Level of evidence: II PEDro score: 6/10	Patients, with mean age of 35.27, were divided into 2 groups: group A received deep transverse friction massage and Mill's manipulation (n = 30), whereas group B received MWM technique (n = 30) for 12 sessions over 4 weeks	Patients with LET of either sex aged 20-50 years, having symptoms for >2 weeks. Patients with pain intensity >7 on the NPRS and/or having history of acute trauma, fractures, surgery and/or having any neurological or systemic disease were excluded.	Patient-rated tennis elbow evaluation (PRTEE)	Pain (PRTEE) after 8 weeks of treatment was found to be significantly decreased in both Cyriax and MWM groups mean and SD 1.93 ffl 0.74 and 1.70 ffl 0.79 respectively (P value = 0.2). Grip strength results (lbs) at posttreatment level for both groups were 53.5 ffl 2.13 and 42.3 ffl 1.97, respectively (P<.01). After 8 weeks of treatment, Cyriax manual therapy and MWM both were equally effective in improving pain; however, because there was no control group, the improvements made in both groups could have been due to the passage of time. The Cyriax approach was better for pain management, whereas Mulligan techniques improved the functional status better in patients with lateral epicondylitis.

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APPENDIX E (CONTINUED)

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Reyhan et al (2020)	RCT	Level of evidence: II PEDro score: 7/10	Forty adults diagnosed with chronic LET (>6 weeks duration).	Randomized into 2 groups; either MWM lateral glide technique plus exercise (for 3 sets of 10 repetitions and instructions in a self-mobilization technique to perform for 10 repetitions every 2 hours) and cryotherapy or exercise and cryotherapy alone. Both groups were treated 5 times a week for 2 weeks. Outcomes measured at baseline, after treatment, 4 weeks, and 3 months after treatment ended.	Pain (VAS), PFGS, PRTEE, and global assessment.	MWM lateral glide in addition to exercise and cryotherapy appears to have a small positive effect on pain, PFGS, and function in the short term.
Zunke et al (2020)	RCT	Level of evidence: II PEDro score: 5/10	A grade III mobilization of the ribs at T5 was performed at 2 Hz (120 impulses per minute) for 2 minutes. For the control group, a sham US therapy was performed on the same segment as in the treatment group for 2 minutes.	Women and men aged between 18 and 55 years with unilateral, acute and subacute (pain duration did not exceed 6 month) lateral epicondylalgia were included.	Pain-free grip, skin conductance and peripheral skin temperature	Mobilization at the thoracic spine resulted in significantly increased strength of pain-free grip and a decrease in peripheral skin temperature within the treatment group.

Abbreviations: LET, lateral elbow tendinopathy; MD, mean difference; MWM, mobilization with movement; NPRS, numeric pain-rating scale; PFGS, pain-free grip strength; PRTEE, Patient-Rated Tennis Elbow Evaluation; RCT, randomized clinical trial; SMD, standardized mean difference; US, ultrasound; VAS, visual analog scale.

APPENDIX E (CONTINUED)

Evidence Table: Manual Therapy Soft Tissue Mobilizations

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Laimi et al (2018)	Systematic review	Level of evidence: II AMSTAR score: 6/11	Examined the effectiveness of myofascial release therapy to relieve chronic musculoskeletal pain and to improve joint mobility, functioning level, and quality of life in individuals with pain.	Two trials focused on lateral epicondylitis	PRTEE	First study: Myofascial release was more effective than conventional physical therapy alone for pain, functional performance, and grip strength. Mean PRTEE difference in PRTEE improvement between the control and LET group was (−47 points; 95% CI: −44.64, −49.36). Second study: Myofascial release is more effective than sham US for lateral epicondylitis in computer professionals. Mean PRTEE difference in PRTEE improvement between the control and the LET group was (−19.3 points; 95% CI: −22.92, −15.68).
Yi et al (2018)	RCT	Level of evidence: II PEDro score: 5/10	Patients were included if they had signs and symptoms consistent with lateral epicondylitis for at least 6 weeks and were greater than 18 years of age.	Three treatments: group 1 (n = 11): splinting and stretching; group 2 (n = 11): a cortisone injection; or group 3 (n = 12): a lidocaine injection with deep friction massage. Outcomes were measured at early follow-up (6-12 weeks) and at 6-month follow-up.	Visual analog scale (VAS) pain ratings, Disabilities of the Arm, Shoulder and Hand (DASH) scores, and grip strength	There was a statistically significant greater effect on VAS, DASH, and grip strength ($P<.05$) for the DFM plus lidocaine injection group at 6 months compared with the other 2 groups (ANOVA). No between-group comparison data were given. Deep friction massage plus lidocaine injection is an effective treatment for lateral epicondylitis and can be used in patients who have failed other nonoperative treatments, including cortisone injection.
Sevier and Steginк-Jansen (2015)	RCT	Level of evidence: II PEDro score: 6/10	The instrument-assisted soft tissue mobilization group received deep pressure with assistive tools from the wrist to the deltoid followed by stretching and eccentric exercises. The eccentric group received the same exercises, and the patients were also instructed to perform the exercises at home. The instrument-assisted soft tissue mobilization group did not perform the exercises at home.	Males and females aged 18-65 years old, diagnosed with lateral epicondylitis (2 or more positive findings with Cozen's, Mill's, and pain upon palpation of the wrist extensor muscle mass or tendon). Symptom duration of at least 12 weeks. One hundred thirteen patients were randomized into 2 groups.	DASH and VAS (0-100)	Subjects treated with instrument-assisted soft tissue mobilization demonstrated greater gains in the DASH (standardized ES, 0.40; 95% CI: 0.00, 0.84) and grip strength (standardized ES, 0.62; 95% CI: 0.16, 1.07) compared to the eccentric strengthening group. However, there were no differences between the groups at 6- and 12-month follow-up.
Loew et al (2014)	Systematic review	Level of evidence: II AMSTAR score: 9/11	RCTs and controlled clinical trials comparing deep transverse friction massage versus no therapy or active treatments (US, phonophoresis, other therapeutic exercise).	Two RCTs were included.	PFGS, pain, function (no pooling of results conducted)	Insufficient evidence to demonstrate a clinically important benefit of deep transverse friction massage when combined with other modalities for treatment of common extensor tendinopathy.

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APPENDIX E (CONTINUED)

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Blanchette and Normand (2011)	Clinical trial	Level of evidence: II PEDro score: 7/10	Participants were randomly assigned to an experimental (n = 15) or a control group (n = 15). The experimental group received 2 treatments of instrument-assisted soft tissue mobilization per week for 5 weeks. The control group received education about the natural history of LET, advice about ergonomics, stretching exercises, and the first level of analgesics.	Eligibility criteria included being 18 years of age or older, having lateral epicondylitis (any duration) confirmed by a positive Mill's and Cozen's test. A total of 30 participants were included in the study.	PRTEE, PFGS, pain	There was not a statistically significant difference in outcomes between the group receiving instrument-assisted soft tissue mobilization and the control group. No between-group data were reported other than *P* values. Within-group means, standard deviations, and 95% CIs were reported.

Abbreviations: ANOVA, analysis of variance; ES, effect size; LET, lateral elbow tendinopathy; PFGS, pain-free grip strength; PRTEE, Patient-Rated Tennis Elbow Evaluation; RCT, randomized clinical trial; US, ultrasound.

Evidence Table: Dry Needling

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Uygur et al (2021)	RCT	Level of evidence: I PEDro score: 8/10	Patients in the DN group received 15 0.25 × 25-mm stainless steel needles that were inserted at the lateral epicondyle region and throughout the course of the extensor carpi radialis brevis tendon. DN was repeated twice weekly. For CS group methylprednisolone acetate injections were given.	One hundred eight patients with lateral epicondylitis whose pain was not relieved by 3 weeks of first-line treatment (NSAID and forearm brace)	Patient-Rated Tennis Elbow Evaluation	DN and CS injection afforded significant improvements during the 6 months of follow-up. However, compared with CS injection, DN was more effective. ($P<.01$). Four patients treated with injection (7.6%) developed skin complications. One patient treated with DN (2.04%) withdrew from the study due to complaints of pain with the DN procedure.
Rodríguez-Huguet et al (2020)	RCT	Level of evidence: I PEDro score: 8/10	Adults diagnosed with lateral epicondylitis	A total of 32 subjects were included in the study inclusion criteria, which were patients of both sexes, aged between 18 and 60 years and diagnosed with LE with a poor evolution after 1 month of passive physical therapy, TENS, and stretching exercise and pharmacological treatment.	Pain pressure threshold, pain intensity, elbow joint range of motion, quality of life	Ultrasound-guided percutaneous electrolysis as an adjunct to an eccentric exercise program is more effective for pain and range of movement than trigger point dry needling as an adjunct to the same exercise program in patients with lateral epicondylalgia. The effect (eta-squared) on pain reduction ($n^2 = 0.46$) was moderate and improved PPT ($n^2 = 0.11$) was small in all 3 follow-ups in favor of the PE groups ($P<.05$). PE could be superior to tendon DN when added to an eccentric exercise program in the management of LET after a 3-month follow-up. Complications and adverse effects were not reported or discussed.

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APPENDIX E (CONTINUED)

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Navarro-Santana et al (2020)	Meta-analysis	Level of evidence: II AMSTAR score: 8/11	Included RCTs where at least one group received any type of dry needling (muscular or tendon) for the management of lateral epicondylalgia of musculoskeletal origin. Included the following diagnostic terms in the meta-analysis: lateral epicondylalgia, epicondylitis, tennis elbow, or lateral elbow tendinopathy	Seven trials were included in the analyses. Six studies targeted active trigger points with the needle, whereas the seventh study targeted the tendon. The methodological quality scores ranged from 6 to 8 (mean = 6.6, SD = 0.8) out of a maximum of 10 points on the PEDro scale.	Pain, related-disability, function, pressure pain threshold, strength	Low to moderate evidence suggests a positive effect of dry needling for pain, pain-related disability, pressure pain sensitivity, and strength at the short term in patients with lateral epicondylalgia of musculoskeletal origin. Dry needling facilitated a decrease in pain (SMD, −1.13; 95% CI: −1.64, −0.62), decrease in disability (SMD, −2.17; 95% CI: −3.34, −1.01), increase in pressure pain threshold (SMD, 0.98; 95% CI: 0.30, 1.67) with larger ESs mainly in the short term when compared to the control group. Grip strength improved when compared to the control group but with a small effect (SMD, 0.48; 95% CI: 0.16, 0.81).

Abbreviations: CS, corticosteroid; DN, dry needling; NSAID, nonsteroidal anti-inflammatory drug; PE, percutaneous electrolysis; PPT, pressure pain threshold; RCT, randomized clinical trial; SMD, standardized mean difference.

Evidence Table: Orthoses

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Shahabi et al (2020)	Systematic review	Level of evidence: II AMSTAR score: 8/11	Studies were included if (1) RCTs (either crossover or parallel designs); (2) adult subjects (greater than 18 years old); (3) reported pain scores in both intervention and comparison groups; and (4) studies in which subjects treated with a counterforce brace were compared to other interventions (physical therapy interventions, other orthoses, laser therapy, or sham).	Search dates through June 2019. Seventeen studies were included in the qualitative analysis and 16 studies were included in the meta-analysis. All the included trials were parallel design. Four studies were rated as "good," 5 studies were rated as "fair," and 8 studies were rated as "poor."	Pain (different measurement tools), grip strength, and function (different measurement tools).	The counterforce brace did not have a statistically significant effect (SMD, 0.02; 95% CI: −0.85, 0.80) on pain compared with other physical therapy interventions for all patients (short term). In younger patients (<45 years), there was no statistically significant effect on pain (SMD, −0.86; 95% CI: −2.45, 0.72). In the long term, other physical therapy interventions seemed to have a greater positive effect than the counterforce brace (SMD, 1.17; 95% CI: 0.00, 2.34).

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APPENDIX E (CONTINUED)

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Heales et al (2020)	Systematic review	Level of evidence: II AMSTAR score: 9/11	Studies were included if they met the following criteria: (1) participants with a clinical diagnosis of LET; (2) the use of an isolated wrist and/or forearm orthosis; (3) a randomized controlled trial or randomized crossover controlled trial; (4) a control condition without an orthosis, or a placebo condition; (5) an outcome measure related to pain (eg, VAS, PPT, PFGS), function (eg, strength) or sensorimotor measures (eg, proprioception); and (6) examined immediate effects (ie, within session).	Seven randomized crossover studies	Pain intensity during wrist extensor muscle contraction, passive stretch force prior to pain, pain intensity following the entire testing condition, PFGS, maximal grip strength, wrist extensor strength, sensorimotor outcomes.	Low-quality evidence is available to support a significant decrease in pain during contraction (SMD range: −0.83 to −0.65) and improvements in PFGS (SMD range: 0.24-0.38) with forearm orthoses compared to a control or placebo. The difference in pain decrease during extensor muscle contraction was greater in individuals wearing a wrist support than a placebo orthosis (MD, −0.48 cm; 95% CI: −0.96, −0.01). There is low-quality evidence that forearm orthoses can immediately reduce pain during contraction and improve PFGS but not maximal grip strength in individuals with lateral elbow tendinopathy.
Healy et al (2018)	Systematic review	Level of evidence: II AMSTAR score: 5/11	Systematic review of RCTs assessing clinical and cost effectiveness of prosthetic and orthotic interventions. Eight studies that examined individuals with LET were included.	Effect size or odds ratios were possible to calculate from pain outcome data provided.	Pain intensity	One study found greater reduction in pain with laser when compared to a lateral counterforce brace (ES, 1.04 (95% CI: 0.35, 1.73), whereas another reported that a lateral counterforce brace reduced pain more than sham laser therapy (ES, −0.8; 95% CI: −1.45, −0.15). Success rates were slightly higher for the physical therapy–plus–lateral counterforce bracing (88%) group compared to the brace-only group (85% success rate). The odds of success (OR = 1.44; 95% CI: 0.49, 4.23) was not statistically different between the groups. No conclusive evidence from the RCTs included in the data extraction was found regarding the effectiveness of the use of an orthosis or a lateral counterforce brace compared with a nonorthotic condition on pain, due to conflicting evidence.
Sims et al (2014)	Systematic review	Level of evidence: II AMSTAR score: 6/11	1. Signs and symptoms of lateral epicondylitis. 2. Evaluated a nonsurgical intervention. 3. Randomized control trial design. 4. Level 1 or 2 evidence.	Fifty-eight RCTs with a variety of nonsurgical treatment approaches prior to February 2013. Five studies examined the effect of either lateral counterforce bracing or a wrist support orthosis on outcomes in patients with LET.	Patient reported pain, function, and disability was often reported for each study; no pooling of results was possible.	Conflicting evidence exists regarding the diagnostic utility of a counterforce brace or wrist orthosis. Orthoses did not provide conclusive evidence of improvement in regards to pain and function.

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APPENDIX E (CONTINUED)

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Bisset et al (2011)	Systematic review	Level of evidence: II AMSTAR score: 7/11	Clinical trial or systematic review regarding any type of intervention approach	Eighty systematic reviews, RCTs, or observational studies that met the inclusion criteria (1 systematic review and 1 RCT regarding orthoses).	Pain, global improvement, and functional improvement	Conflicting evidence for or against the use of orthoses. Corticosteroid injections were more effective in the short term (RR, 2.9; 95% CI: 1.8, 5.7), on global improvement scores compared with orthosis, but not at the intermediate term (RR, 0.70; 95% CI: 0.46, 1.05) or long term (RR, 0.90; 95% CI: 0.60, 1.03). Low- to medium-quality studies have reported that the use of a wrist orthosis or elbow strap does not appear to have a positive effect when compared to cortisone injection at 2 weeks and 6 or 12 months. However, the use of a lateral counterforce strap appears to be more effective in enabling individuals with LET to perform daily activities in the short term (6 weeks) when compared to pulsed US plus friction massage plus exercise.
Borkholder et al (2004)	Systematic review	Level of evidence: I AMSTAR score: 7/11	RCTs that examined the effectiveness of an orthosis for the treatment of lateral elbow tendinopathy	Eleven RCTS met the criteria. Ten of the studies were rated at a 2b quality, whereas 1 study was rated at 1b.	Pain and other objective findings such as wrist strength and handheld dynamometry	A lateral counterforce brace, regardless of style, resulted in increased grip and wrist extensor strength in symptomatic individuals. One study evaluated the effect of 3 types of wrist support orthoses in normal individuals on electromyographic (EMG) signal intensity in the wrist extensors and grip strength. All styles of wrist orthoses resulted in similar decreased grip strength compared with no orthosis; the semicircular wrist support orthotic design resulted in reduced EMG signal intensity in the wrist extensors compared with the dorsal and volar designs.

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APPENDIX E (CONTINUED)

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
MacDermid et al (2010)	Survey study	Level of evidence: V	N/A	Six hundred and ninety-three members of the American Society of Hand Therapists or individuals who were certified hand therapists identified through the Hand Therapy Certification Commission (estimated 37% response rate) responded to the survey.	The survey consisted of structured questions related to respondent demographics, as well as questions regarding the examination, prognostic factors, and interventions used in the management of individuals with LET.	Respondents were predominantly female (85%) and their average time in practice was 18.7 years; 81% were certified hand therapists. Respondents were asked about 49 treatments often used in the management of individuals with LET. Ranks of how frequent the interventions were used and their perceived effectiveness were listed. Eighty-one percent of respondents reported using either a forearm counterforce or wrist support orthosis for immediate pain relief in individuals with LET whose pain was aggravated with activities. Respondents ranked orthoses the 4th most effective intervention in alleviating symptoms of LET behind rest/activity modification (first), a home exercise program (second), and stretching (third).

Abbreviations: ES, effect size; LET, lateral elbow tendinopathy; MD, mean difference; PFGS, pain-free grip strength; PPT, pressure pain threshold; RCT, randomized clinical trial; RR, relative risk; SMD, standardized mean difference; US, ultrasound; VAS, visual analog scale.

Evidence Table: Taping

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Zhong et al (2020)	Meta-analysis	Level of evidence: I AMSTAR score: 7/11	Inclusion criteria: RCTs that included participants with diagnosis of LET who had received kinesiology tape, sham taping, or physical therapy, and at least one of the following outcome measures was reported: pain score, functional outcome, PFGS, and adverse events.	Five RCTs with a total of 168 patients were included in the MA, all with low risk of bias.	Visual analog scale (VAS), grip strength; Modified Mayo Performance Index; Disabilities of the Arm, Shoulder and Hand (DASH) score, and adverse events	Kinesiology tape yielded statistically superior pain scores, grip strength, Modified Mayo Performance Index, and DASH score. Improvements in pain (WMD, −0.46; 95% CI: −0.90, −0.02), grip strength (WMD, 1.63; 95% CI: 0.27, 3.00), function as measured by the Modified Mayo Performance Index (WMD, 4.23; 95% CI: 2.80, 5.65), and function as measured by the DASH score (WMD, −5.25; 95% CI: −9.10, −1.39) in the kinesiology taping group over the control groups. The most common adverse effect reported was skin irritation from the tape. Kinesiology tape is effective in relieving pain, restoring grip strength, and improving function in LET.

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APPENDIX E (CONTINUED)

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Bisset et al (2005)	Meta-analysis	Level of evidence = I AMSTAR = 7/11	RCTs that included participants with diagnosis of lateral epicondylitis treated with a relevant physical intervention measured by at least one clinically relevant outcome measure.	One high-quality study was included that assessed the immediate effects of a specific taping technique (rigid diamond-deloading taping) in participants whose mean duration of symptoms was more than 1 year.	PFGS, pressure pain threshold	PFGS improved 24% from baseline, and pressure pain threshold improved when measured immediately and 30 minutes postintervention compared with the placebo rigid tape and no-tape groups.
George et al (2019)	Systematic review	Level of evidence: II AMSTAR score: 9/11	Searched up to March 2018. Studies were eligible for inclusion if they had a population with LET; a tape-only "intervention" (eg, rigid tape, kinesiology tape) with no other concurrent treatment; an untaped comparator condition provided either as a baseline measurement (ie, before application), a separate experimental condition, or an unaffected limb; an outcome related to pain or function and a full-text, peer-reviewed, English-language manuscript. Single-subject case studies, conference abstracts, retrospective studies, and reviews were excluded.	Eight included studies examining either rigid taping or kinesiology tape, and placebo taping techniques on the immediate or short-term effects on outcomes. Several studies demonstrated high risk of bias.	Pain intensity, mechanical pain sensitivity, strength, sensorimotor outcomes, and participant-rated function (DASH, PRTEE). For the immediate effects of tape, outcomes were measured at 0 min, or at 0 and 30 minutes, following each condition. In short-term treatment studies, tape was applied multiple times over 1 or 2 weeks, with or without measurement of outcomes.	Studies reported improvement in outcomes based on percentages and therefore pooling of data was not possible. There is a lack of consistent high-quality evidence. Based on the included studies, application of rigid tape using a diamond deloading technique is likely to immediately improve pain and function in individuals with LET. It is unclear whether kinesiology tape influences pain and function immediately or in the short term. Data are unable to be pooled; most reported percent change in outcomes. No adverse effects are reported.
Özmen et al (2021)	RCT	Level of evidence: II PEDro score: 6/10	Forty patients with lateral elbow tendinopathy. Inclusion criteria were as follows: (1) pain around the lateral epicondyle during the extension of wrist and fingers against resistance; (2) tenderness over the lateral epicondyle; and (3) symptoms lasting for at least 3 months.	Patients were randomly assigned to 3 treatment groups: (1) US, (2) ESWT, (3) kinesiology tape	The VAS, grip strength, and the PRTEE Scale	All treatment interventions had statistically significant results in reduced pain intensity during ADL at the end of the treatment and at 6 weeks following completion of treatment. Grip strength significantly increased after 8 weeks in only the kinesiology tape group ($P<.05$). The PRTEE scores significantly decreased after 2 weeks and after 8 weeks in the US group and ESWT groups, and after 8 weeks in the kinesiology tape group.

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APPENDIX E (CONTINUED)

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Martínez-Beltrán et al (2021)	RCT	Level of evidence: II PEDro score: 7/10	Individuals clinically diagnosed with LET with symptoms of unknown duration	One hundred four participants were randomized to 2 groups. Group 1: kinesiology tape using "I" muscle toning technique applied from lateral epicondyle to wrist (n = 52). Group 2: kinesiology placebo taping using a 5-cm-wide white athletic bandage with no tension applied (n = 52). Participants received a 1× taping application with outcomes measured immediately prior to and after taping.	Isometric wrist extensor, grip, and isokinetic pronation and supination strength by Baltimore Therapeutic Equipment (BTE) isokinetic dynamometer.	No significant differences ($P<.05$) in any other variables between the 2 groups. No statistically significant intergroup differences were found regarding maximum strength variables or regarding the time for reaching maximal strengthening of any of the movements studied. No adverse effects or harms were reported.
Mansiz-Kaplan et al (2021)	RCT	Level of evidence: II PEDro score: 6/11	Individuals with LET >3 months duration	Eighty-seven participants: 44 randomized into the control group and 43 into the kinesiology tape experimental group. Both groups took oral naproxen and were instructed in activity modification and a HEP. Additionally, the kinesiology tape group received kinesiology tape application 3 times a week for 2 weeks, for a total of 6 sessions using the inhibitor and mechanical correction taping techniques.	Clinical (VAS, PRTEE) and ultrasonographical evaluations (CET thickness, radial nerve CSA) were performed before and after treatment (second week, sixth week, and 14th week).	Improvement in VAS, PRTEE-pain, and PRTEE-function in the second and sixth weeks were statistically significant in all groups ($P<.001$). In the kinesiology tape group, the decrease in VAS, PRTEE-pain, and PRTEEfunction was significant for the 14th weeks ($P<.001$). However, in the control group, there were no significant differences in terms of VAS, PRTEE-pain and PRTEE-function at the 14th weeks ($P>.05$). The improvement in all parameters was superior in the kinesiology tape group.

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APPENDIX E (CONTINUED)

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Tezel et al (2020)	RCT	Level of evidence: II PEDro score: 5/10	Forty-eight patients with chronic LET	Inclusion criteria were as follows: (1) age between 18 to 65 years, (2) pain and tenderness on the lateral epicondyle for at least 3 months, and (3) provocation of the lateral elbow pain with at least one of the tests (ie, resisted wrist extension, resisted middle finger extension, or passive stretch of wrist extensors). These patients were randomly assigned to either the kinesiology tape group or the sham group.	Pain intensity with VAS, arm pain and function with PRTEE questionnaire, grip strength with hand dynamometer, and wrist extensor strength by an isokinetic device.	Pain and functional levels of patients with chronic LE were significantly improved both with kinesiology tape (pain, $P = .001$; function, $P = .001$) and sham groups (pain, $P = .001$; function, $P = .001$), but no significant difference was observed between the groups.

Abbreviations: ADL, activities of daily living; CET, common extensor tendon; CSA, cross-sectional area; DASH, Disabilities of the Arm, Shoulder and Hand; ESWT, extracorporeal shock wave therapy; LET, lateral elbow tendinopathy; PFGS, pain-free grip strength; PRTEE, Patient-Rated Tennis Elbow Evaluation; RCT, randomized clinical trial; US, ultrasound; VAS, visual analog scale; WMD, weighted mean difference.

APPENDIX E (CONTINUED)

Evidence Table: Cryotherapy

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Macedo et al (2015)	RCT	Level of evidence: II PEDro score: 5/10	Patients were selected via convenience sampling and were randomly divided into 7 groups: (1) Control group (25-minute rest) (2) Placebo TENS (turned on- no amp) (3) Conventional TENS (symmetrical biphasic pulsed current; frequency: 100 Hz, duration: 100 μs and motor level amp) (4) Burst TENS (100 Hz burst-modulated at 4 Hz, duration: 200 μs, and motor level amp) (5) Cryotherapy (ice pack applied to lateral elbow) (6) Cryotherapy and burst TENS (combination of groups 4 and 5) (7) Cryotherapy and conventional TENS (combination of groups 3 and 5) A baseline measure of pain threshold was taken at the lateral epicondyle with a pressure algometer before the selected intervention (group dependent). All interventions lasted 25 minutes. Another pain threshold measure was taken immediately following the intervention.	Inclusion criteria for the study consisted of young healthy females between the ages of 18-25 (BMI < 28 kg/m^2) with no history of UE injury in the past 6 months and not using analgesic medications. A total of 112 females participated in the study (16 per group)	No formal outcome measure; pain threshold assessment	The greatest analgesic effect was found within group 6 with the combination of cryotherapy and burst TENS ($P \leq .001$) demonstrating its usefulness with pain relief. Pain threshold and pain tolerance declined in control and placebo groups, increased in groups that received burst TENS with or without cryotherapy and cryotherapy alone, and no change found with conventional TENS with or without cryotherapy. The burst TENS plus cryotherapy group showed significantly superior pain tolerances (MD, 4.9; 95% CI: 4.8, 5.0) compared with all other groups.

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APPENDIX E (CONTINUED)

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Agostinucci et al (2013)	RCT: the participants chose their group number at random from 1 to 4	Level of evidence: III PEDro score: 4/10	Participants were selected via convenience sampling. Baseline measures of grip strength, VAS scores on single-arm chair pick-up, and DASH scores were recorded. Participants were randomly assigned to groups: Group 1: exercise only, Group 2: exercise and standard gel pack, Group 3: CryoMAX and exercise, Group 4: CryoMAX only. All groups were given the same HEP consisting of 3 exercises: (1) resisted forearm supination with Theraband (TB) 3×10, (2) resisted wrist extension with TB 3×10, and (3) straight arm wrist extensor stretch (20-s hold 3×). Groups 2 and 3 were given the appropriate ice pack and told to apply after exercise for 20 minutes, 10 minutes off, then 20 minutes again. Group 4 completed 3 cycles of 20 minutes on 20 minutes off. All groups completed protocols at least 4 times a week for 6 weeks. Daily logs were taken; and participants were reassessed at 6 weeks with same 3 screening tests.	Of the 70 participants who started the study only 49 completed the study. Inclusion criteria included individuals over 18 years, pain localized to the lateral elbow, symptoms present for >3 months, no previous treatment or surgery in the past 3 months, or no history of musculoskeletal or neuromuscular disorders of the UE. Physical inclusion examination included a minimum of 3/10 on the VAS on 2 out of 6 provocation tests, which included resisted wrist extension (with elbow extended or with elbow flexed at 90 degrees), resisted third-digit extension with elbow in extension, ability to lift chair with elbows in extension and forearms pronated (with both arms or with only affected arm), and pain with palpation. Twenty-one participants dropped out of the study for "various reasons."	VAS scores and DASH	All 4 groups showed significant changes in all 3 measures demonstrating no significant difference between exercise and cryotherapy or a combination of the two for treating lateral epicondylalgia. All 4 treatment groups showed improved DASH scores (average of 47.6%), which meets the minimal important change requirement. All groups also had decreased VAS scores (average of 37.5%) and increased grip strength (average of 15%). However, without a control group, it is not possible to know if changes are attributed to time, placebo, or the treatment itself.

Abbreviations: BMI, body mass index; DASH, Disabilities of the Arm, Shoulder and Hand; MD, mean difference; TENS, transcutaneous electrical nerve stimulation; RCT, randomized clinical trial; UE, upper extremity; VAS, visual analog scale.

APPENDIX E (CONTINUED)

Evidence Table: Ultrasound

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Hüseyin Ünver et al (2021)	RCT	Level of evidence: II PEDro score: 7/10	Adults with LET who presented with pain on the lateral side of the elbow for less than 6 months, tenderness over the lateral epicondyle, and pain during extension of the wrist and digits	Fifty-one patients were randomized into either continuous US (n = 17), pulsed US, or placebo US groups. All received 10 sessions of treatment for 5 minutes once per day for 2 weeks. Continuous US therapy group received 1.5 MHz frequency, and 1 W/cm^2 power was applied with a 5-cm diameter applicator. The second group received US with same parameters using pulsed-wave (1:4) US. The third group received sham US application.	Pain (VAS), PRTEE, (maximum) grip strength	At 2 weeks, all outcomes were significantly improved in all groups (P<.05). Pain and function demonstrated greater improvements in both the continuous and pulsed US groups compared with sham US. Each group's baseline, 2-week, and 6-week mean scores with SD were reported; however, values of differences between groups and effect sizes were not reported.
Özmen et al (2021)	RCT	Level of evidence: II PEDro score: 6/10	Forty patients with LET. Inclusion criteria were as follows: (1) pain around the lateral epicondyle during the extension of wrist and fingers against resistance, (2) tenderness over the lateral epicondyle, and (3) symptoms lasting for at least 3 months.	Group 1: ultrasound (US) therapy, Group 2: extracorporeal shock wave therapy (ESWT), Group 3: kinesiology tape	The VAS, PRTEE, and grip strength were measured at baseline, 2 weeks, and 8 weeks.	Only the kinesiology tape groups showed significantly increased grip strength at 8 weeks (P<.05). PRTEE scores significantly decreased after 2 weeks and after 8 weeks in the US group and ESWT groups, and after 8 weeks in the kinesiology tape group (P<.05).

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APPENDIX E (CONTINUED)

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Yalvac et al (2018)	Prospective, randomized, single blind, clinical trial	Level of evidence: II PEDro score: 7/10	Fifty adults with at least 3 months duration of symptoms, diagnosed as chronic LET.	Group 1 received therapeutic US (n = 24; 5 males and 15 females; mean age: 43.75 ± 4.52). Group 2 received ESWT (n = 20; 8 males and 16 females; mean age: 46.04 ± 9.24). Therapeutic US was administered at 1.5 W/cm^2, 1-MHz frequency, continuous mode to the painful area, 5 minutes once a day, 5 days a week, for 10 sessions in total.	VAS, algometer, grip dynamometer, quick-disability of the arm, shoulder and hand (QuickDASH), PRTEE, and Short Form-36 (SF-36) health survey questionnaire. Outcomes collected at baseline, after treatment, and 1 month after treatment concluded.	ESWT and therapeutic US are equally effective in treating LET. ESWT is an alternative therapeutic intervention and is as effective as US. No differences in improvement in outcomes were demonstrated in either group. Both ESWT and therapeutic US were equally effective in treating LET in the short term especially with improving VAS pain scores (MDs >22/100 for both treatments) and QuickDASH scores (MDs >15/100 for both treatments).
Lizis (2015)	RCT	Level of evidence = II PEDro score: 6/10	Fifty individuals with chronic LET (symptoms persisting past 12 months) were randomly allocated by a blinded statistician to 2 groups	(1) US: received continuous US (intensity: .8 W/cm^2; frequency: 1 MHz) 3 times a week for 10 treatments (tx) applied directly to the lateral epicondyle for ≤10 minutes. (2) Extracorporeal shock wave therapy (ESWT): received 1000 (first tx), 1500 (second tx), and 2000 (third-fifth txs) pulses (pressure: 2.5 bar; frequency: 8 Hz; density: .4 mJ/mm2) 1 time a week for 5 weeks. Tx was ≤10 minutes and applied to the most painful area of the lateral elbow.	Pain (VAS) levels were tested at baseline, immediately following completion of intervention, and 3 months postintervention. Pain was assessed through palpation, grip strength, resting levels, during Thomsen test (Cozen's) and chair test.	Both groups had a significant decrease in pain levels throughout the study; however, the ESWT group experienced a significantly greater analgesic effect (88% reporting good or excellent pain reduction immediately postintervention and 96% 3 months postintervention) than the US group (28% reporting good pain reduction immediately following and 3 months postintervention with no individuals reporting excellent pain relief). This suggests that ESWT is more efficient at immediate and long-lasting pain management when compared to US.

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APPENDIX E (CONTINUED)

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Hoogvliet et al (2013)	Systematic review	Level of evidence: II AMSTAR score: 6/11	Studies that included the evaluation of several therapeutic interventions: stretching, strengthening, concentric/eccentric exercises, and manipulation of the cervical or thoracic spine, elbow, or wrist for the treatment of lateral or medial elbow tendinopathy.	A total of 12 RCTS and 1 review were included; 1 review and 1 recent RCT discussed US as an intervention.	Pain, function, grip strength (no pooling of results conducted)	No evidence was found to support US as a treatment method compared with an exercise and stretching program for the treatment of LET. Even when US was combined with friction massage, an exercise and stretching program showed better short-term improvements. US plus friction massage was less effective in reducing pain than exercise in the short term (8 weeks) (SMD, 0.95; 95% CI: 0.26, 1.64) and long-term (36 months) follow-up (MD, −2.3 cm; 95% CI: −4.5, 0.01) supported by moderate and limited evidence respectively. Limited evidence supported the use of wrist manipulation over the use of US plus friction massage and exercises on pain during the day ($P = .03$) in the short term. Limited evidence suggested that US was more effective in providing pain relief and improving pain-free function than chiropractic care and exercise in the short term (6 weeks).
Dingemanse et al (2014)	Systematic review	Level of evidence: II AMSTAR score: 5/11	Reviews and RCTs that focused on multiple electrophysical modalities to treat lateral and medial epicondylitis were included. Modalities examined were US, ESWT, TENS, and laser therapy.	Two reviews and 20 RCTs were included within the systematic review; US was included in nine of the included articles. Search included articles that were published up to August 2012.	Pain, grip strength, and function (no overall pooling of results). Specific outcome tools used in each study varied	There was moderate evidence found in the effectiveness of US in treating lateral epicondylitis. Some evidence supporting US vs a placebo and moderate evidence to support that US in combination with friction massage is more effective than laser therapy. US was more effective at reducing pain and improving global function than a placebo treatment at 13 weeks based on moderate evidence. Pooled data showed a significant improvement on pain (SMD, −0.98; 95% CI: −1.64, −0.33) in the US group compared to a placebo or no treatment in the mid-term. However, there was conflicting evidence regarding the benefit of US in the short term. In addition, the combination of US with friction massage was more effective in reducing pain than laser therapy (SMD, −0.84; 95% CI: −1.58, −0.09) at 6 weeks.

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APPENDIX E (CONTINUED)

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Bisset et al (2005)	Systematic review and meta-analysis	Level of evidence: II AMSTAR score: 7/11	The review included studies that had participants with confirmed diagnosis of lateral epicondylitis, included at least one physical agent for therapeutic intervention, were randomized, compared at least 2 groups, and included at least one relevant outcome measure.	The review included 28 RCTs; 5 studies looked at the effectiveness of US.	Pain scores (PVAS or ordinal scale), grip strength, improvement (data was pooled for some interventions but not all data for US was pooled)	Insufficient evidence to support or refute US as a unimodal treatment for lateral epicondylitis. Even though some studies showed an improvement in outcome measures in short-term follow-ups (up to 3 months), all studies showed no difference between groups. One high-quality study (Smidt et al) found the combination of US, friction massage, and exercise was more effective in the management of LET in the long term than corticosteroid injections but was not more effective than the control group of no intervention.

Abbreviations: ESWT, extracorporeal shock wave therapy; LET, lateral elbow tendinopathy; MD, mean difference; PRTEE, Patient-Rated Tennis Elbow Evaluation; PVAS, pain visual analog scale; RCT, randomized clinical trial; VAS, visual analog scale.

Evidence Table: Phonophoresis

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Baktir et al (2019)	Randomized parallel group trial	Level of evidence: II PEDro score: 7/10	Adults with LET	Twelve participants were randomized to each group. LLLT group (wavelength of 904 nm, 50 Hz, and maximum peak power of 0.12 mW, applied to lateral epicondyle and 4 painful points surrounding it for unknown amount of time, the phonophoresis group (Prednisolone (2 mg/d) was mixed with aquasonic US gel at applied with a 5 cm^2 applicator using 1 W/cm^2 and 1 Mz for 7 minutes), and to the iontophoresis group (using 5 mL of 0.4% prednisolone to the active negative electrode placed over the lateral epicondyle for 40 mA min). All participants received treatment at the clinic (5 times a week), consisting of 15 sessions of approximately 20 minutes.	The visual analog scale (VAS), pressure algometer, the Patient-Rated Tennis Elbow Evaluation (PRTEE), and grip strength dynamometer	Within-group mean change in scores were reported for each outcome. There were no significant differences between groups improvements in pain at rest ($P = .07$), pressure pain threshold ($P = .89$), grip in elbow extension ($P = .06$), or function ($P = .97$). When compared to phonophoresis, iontophoresis has better effects for pain, function, and grip strength. Overall, phonophoresis does not appear to be a viable treatment option for this population of LET.

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APPENDIX E (CONTINUED)

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Nagrale et al (2009)	RCT	Level of evidence: II PEDro score: 7/10	Sixty patients with LET	Randomly assigned to receive either 10 minutes of deep transverse friction massage plus a single application of Mill's manipulation or phonophoresis using a 1% diclofenac sodium gel plus supervised exercise	Pain, PFGS, and PRTEE	Both groups demonstrated improvement in pain, PFGS, and function as measured by the PTREE at 4 and 8 weeks. The group receiving transverse friction massage and manipulation demonstrated significantly better outcomes than the group receiving phonophoresis plus supervised exercise at the 8-week follow-up. The calculated effect size of this group at the 8-week follow-up was 0.74 for PFGS, −0.74 for function, and −0.81 for VAS.
Bisset et al (2011)	Systematic review	Level of evidence: II AMSTAR score: 7/11	Adults who were diagnosed with tennis elbow with the following inclusion criteria; published systemic reviews, RCTs (in any language), at least single blinded, including >20 individuals of whom >80% were followed up.	Two systematic reviews that included 2 RCTs that compared US to phonophoresis (with corticosteroid agent); one "low-quality RCT" examined the difference between iontophoresis and phonophoresis	Pain, grip strength, PFGS	One study found that there was no significant difference between US and phonophoresis in grip strength, pain, or PFGS. The addition of friction massage to the 2 treatment groups also did not significantly impact moderate-term (5 weeks) outcome measures. The other study examined short-term results (5 days) of bracing, activity modifications, and ice massage combined with US or phonophoresis. No significant difference was found between groups. More high-quality evidence is needed to determine if iontophoresis or phonophoresis is better at reducing pain and increase function.

Abbreviations: LET, lateral elbow tendinopathy; LLLT, low-level laser treatment; PFGS, pain-free grip strength; RCT, randomized clinical trial.

Evidence Table: Iontophoresis

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
da Luz et al (2019)	RCT	Level of evidence: II PEDro score: 7/10	Adults with LET (unilateral or bilateral who had not received any treatment in the past 4 weeks).	Twenty-four participants randomly assigned to the iontophoresis (n = 12) or the galvanic current (n = 12) group	Pain (VAS), grip strength (maximum), and function PRTEE	At final measurements, the iontophoresis group demonstrated significantly lower pain at rest than the galvanic current group ($P = .002$). The mean (SD) pain level in the galvanic current group reduced from 3.50 (2.11) to 2.50 (1.57) ($P = .032$) and the iontophoresis group demonstrated pain reduction from 3.83 (1.80) to 0.58 (0.99) ($P<.001$). Pain with exertion and PTREE scores were also less in the iontophoresis group compared with the galvanic current group ($P<.001$). No significant differences in grip strength were seen between groups.

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APPENDIX E (CONTINUED)

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Baktir et al (2019)	Randomized parallel group trial	Level of evidence: II PEDro score: 7/10	Adults with LET	Twelve participants were randomized to the LLLT group, 12 to the phonophoresis group, and 13 to the iontophoresis group	VAS, pressure algometer, PRTEE, and grip strength dynamometer	Along with improvements in pain (ES = 1.22), function and grip strength were associated with the iontophoresis group (PRTEE, *P* = .006; ES = 0.78; grip strength with elbow extension, *P* = .011; ES = 1.03; with elbow flexion, *P* = .003; ES = 0.52) Of the 3 modalities (iontophoresis, laser, and phonophoresis), iontophoresis was the only modality shown to be beneficial for improving pain and function on the PRTEE.
Sims et al (2014)	Systematic review	Level of evidence: II AMSTAR score: 6/11	Review of RCT to assess the conservative treatment options for lateral epicondylitis. Article inclusion criteria were patients with lateral epicondylitis, an RCT, and at least one of the following conservative interventions: corticosteroid injections, iontophoresis, botulinum toxin A injections, prolotherapy, plasma or blood injections, bracing, physical therapy, shockwave therapy, or laser therapy.	Fifty-eight RCTs of level I or II quality (double or single blinded) were included within the review; 4 RCTs specifically examined iontophoresis.	Pain levels, functional status, grip strength	All studies found significant short-term pain relief with the use of iontophoresis when compared to a placebo using either sodium diclofenac, sodium salicylate, or dexamethasone; however, pain scores were not significantly different at moderate- to long-term follow-ups. One study reported pain score reduction for up to 18 days. Conflicting results were found regarding iontophoresis impact on functional status; one study found no significant change in function compared to a placebo group when another study found "improved grip strength and higher return to work without restrictions at the end of therapy" when compared to dexamethasone and triamcinolone injections. The existing literature does not provide enough evidence that one method of nonoperative treatment is preferable over another.
Bisset et al (2011)	Systematic review	Level of evidence: II AMSTAR score: 7/11	Adults who were diagnosed with tennis elbow with the following inclusion criteria; published systematic reviews of RCTs and RCTs in any language, at least single blinded, and containing >20 individuals of whom >80% were followed up.	Four systematic reviews, 2 RCTs	Pain levels, global improvement, functional improvement	When comparing the effects of iontophoresis with a placebo or other interventions, very low-quality evidence supports the use of iontophoresis coupled with an active anti-inflammatory drug at 2 weeks but not at 4 weeks for reducing pain. It was unclear whether iontophoresis improved the patient's self-reported global improvement at 1 to 3 months in those with LET.

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APPENDIX E (CONTINUED)

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Kohia et al (2008)	Systematic review	Level of evidence: II AMSTAR score: 6/11	Review examined RCTs to discover the most appropriate treatment protocol for lateral epicondylitis. Interventions in the study included iontophoresis, phonophoresis, US, bracing, Cyriax physiotherapy, shockwave therapy, Bioptron light therapy, glyceryl trinitrate transdermal patch, and standard physical therapy protocols. Articles were assessed and included based on the Megens and Harris evaluation tool.	Twelve RCTs were included within the results; 7 studies were classified as level I evidence, and 9 studies were classified as level II. Four studies were evaluated but not included in the results due to "lack of scientific rigor" (unsure of which level of evidence the dropped studies were); 2 level II studies included iontophoresis as a chosen intervention.	Pain scores (VAS), grip strength	When naproxen iontophoresis was compared with naproxen phonophoresis, both groups showed a decrease in VAS scores and an increase in grip strength; however, no significant difference was found between the 2 interventions. When iontophoresis was coupled with infrared treatment, the group that received iontophoresis with sodium diclofenac demonstrated a greater reduction in pain than the group that received iontophoresis with sodium salicylate (both groups saw pain reduction).

Abbreviations: ES, effect size; LET, lateral elbow tendinopathy; PFGS, pain-free grip strength; PRTEE, Patient-Rated Tennis Elbow Evaluation; RCT, randomized clinical trial; VAS, visual analog scale.

Evidence Table: TENS

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Macedo et al (2015)	RCT	Level of evidence = II PEDro score: 5/10	Participants were randomly assigned to 7 groups: control, placebo TENS, conventional TENS, burst TENS, cryotherapy, cryotherapy + burst TENS, and cryotherapy + conventional TENS. Participants' arms were supported and their elbows are flexed to 90 degrees, and pressure tolerance was measured with a pressure algometer both before and after the intervention.	Subjects eligible were 120 females between 18 and 25 years old with no history of upper limb injury in the last 6 months, BMI < 28 kg/m^2, not using analgesics, and no skin or vascular alterations or sensitivities.	Pain threshold and tolerance	Cryotherapy and burst TENS are effective therapeutic agents for the reduction of pressure-induced pain, especially when used concurrently. However, application of cryotherapy with conventional TENS was found to reduce the individual effects of either therapy.
Dingemanse et al (2013)	Systematic review	Level of evidence = II AMSTAR score = 5/11	Systematic reviews and/or RCTs that had patients with medial or lateral epicondylitis not caused by acute trauma or systemic disease and examined interventions for treating epicondylitis and their results on pain, function, or recovery.	One study assessed the efficacy of low-frequency, high-frequency, and sham TENS versus placebo on acupuncture points.	Pain	Low-quality evidence showed that in the short term (at 2-week follow-up) there was a significant difference in pain reduction between high-frequency TENS and sham TENS, and the low-frequency TENS and sham TENS. No significant difference on pain was found between the high-frequency TENS and low-frequency TENS.

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Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Chesterton et al (2013)	RCT	Level of evidence = II PEDro score: 7/10	Participants were randomly assigned to a TENS + primary care management or primary care management alone. Primary care management participants were given advice on activity, self-management, and progressive exercises. The TENS group received the same primary care management information but were also given a TENS machine and instructed to use it at least 1 time a day for 45 minutes on days where pain persisted. The frequency was 110 Hz with a pulse duration of 200 μs and intensity tolerable to participants as a "very strong tingling/buzzing" sensation. They were advised to use the machine for a minimum of 6 weeks when pain occurred.	Eligibility criteria were patients aged over 18 years with a new clinical diagnosis of LET, which was defined as pain and tenderness over the region of the common extensor tendon origin that increased on resisted extension of the wrist or on grip. Two hundred forty-one subjects were included in the study.	Intensity of pain over the last 24-hour period at 6 weeks, 6 months, and 12 months; global change in elbow pain, function, number of sick days due to symptoms, general health, Short Form-12 (SF-12) physical and mental subscales	No additional benefit of supplementing primary care management with self-administered TENS for 6 weeks. At final examination (6 weeks), the between-group MD in pain was −0.33 (95% CI: −0.96, 0.31).

Abbreviations: BMI, body mass index; LET, lateral elbow tendinopathy; MD, mean difference; RCT, randomized clinical trial; VAS, visual analog scale; TENS, transcutaneous electrical nerve stimulation.

Evidence Table: Laser

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Kaydok et al (2020)	RCT	Level of evidence: I PEDro score: 8/10	Sixty patients with LET were randomized into 2 groups	To evaluate the short-term effectiveness of high-intensity laser therapy (HILT) and low-intensity laser therapy (LILT). Along with laser treatments, both groups received an epicondylitis bandage.	The outcome measures used were VAS, Quick-DASH, Short Form-36 (SF-36), and handgrip strength measured at baseline and 3 weeks.	Both groups showed significant within-group improvement. When between group effects were compared the HILT group, demonstrated significant improvements in QuickDASH, SF-36 (PCS) score, and grip strength scores ($P<.05$). Both HILT and LILT were safe and effective in the shorter term for treatment of LET; however, HILT was superior to LILT in improving function and grip strength.

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APPENDIX E (CONTINUED)

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Lian et al (2019)	Systematic review	Level of evidence: II AMSTAR score: 7/11	Inclusion criteria were (1) randomized placebo-controlled trials of a nonoperative treatment for ECRB, (2) at least 10 adult participants, (3) follow-up >1 week, (4) full-text availability, and (5) outcome measurements of pain intensity (as measured by the VAS) and/or grip strength.	Thirty-six randomized placebo-controlled trials, evaluating 11 different treatment modalities, with a total of 2746 patients were included.	Studies using the VAS for pain scores and/or grip strength	At short-term follow-up, only local corticosteroid injection improved pain; however, it was associated with pain worse than placebo at long-term follow-up. At midterm follow-up, laser therapy and local botulinum toxin injection improved pain. At long-term follow-up, extracorporeal shock wave therapy provided pain relief. With regards to grip strength, only laser therapy showed better outcomes in comparison with placebo. The combined effects sizes for the studies resulted in favorable outcomes for laser therapy versus sham/placebo in the intermediate term (SMD, 1.313; 95% CI: 0.514, 2.111). In addition, at midterm follow-up, laser therapy was the sole treatment modality shown to improve grip strength (SMD, 0.576; 95% CI: 0.286, 0.866).
Baktir et al (2019)	Randomized parallel group trial	Level of evidence: II PEDro score: 7/10	Adults with LET	Twelve participants were randomized to the LLLT group, 12 to the phonophoresis group, and 13 to the iontophoresis group	VAS, pressure algometer, the PRTEE, and grip strength dynamometer	Along with improvements in pain, improvements in function and grip strength were associated with the iontophoresis group (PRTEE, $P = .006$; ES = 0.78; grip strength with elbow extension, $P = .011$; ES = 1.03; with elbow flexion, $P = .003$; ES = 0.52). Of the 3 modalities (iontophoresis, laser, and phonophoresis), iontophoresis was the only modality shown to be beneficial for improving pain and function on the PRTEE.
Dingemanse et al (2013)	Systematic review	Level of evidence = II AMSTAR = 5/11	Systematic reviews and/or RCTs that had patients with medial or lateral epicondylitis not caused by acute trauma or systemic disease and examined interventions for treating epicondylitis and their results on pain, function, or recovery.	Six studies reported on effectiveness of laser versus placebo.	Pain	Laser therapy was found to be inferior to US plus friction massage for reducing pain (SMD, −0.84; 95% CI: −1.58, −0.09) in the short term (6 weeks) based on moderate evidence; however, there was no difference in global improvement. When compared to placebo, the evidence was conflicting regarding the effectiveness on pain, grip strength, and function; however, there appeared to be no difference in effect on midterm (6 weeks-6 months) and long-term (greater than 6 months) pain relief. Laser therapy resulted in improvements in pain at rest ($P<.05$) and grip strength ($P<.01$) when compared to plyometric exercises at 8-week follow-up based on moderate evidence. Conflicting evidence or evidence of no significant effect was found; however, laser is favored over plyometric exercises.

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APPENDIX E (CONTINUED)

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Sims et al (2014)	Systematic review	Level of evidence = II AMSTAR = 6/11	Randomized controlled trials examining nonsurgical treatment of lateral epicondylitis	Eight studies (both RCTs and double-blind RCTs) examined the effect of low-intensity laser therapy versus placebo.	Pain, grip strength, functional assessment	Four early studies found that there was no statistically significant improvement in symptoms. Four later studies found statistically significant differences between the low-intensity laser therapy groups and placebo groups. Results are inconclusive.
Chang et al (2014)	Systematic review	Level of evidence = II AMSTAR = 9/11	Randomized controlled trials that examined manual or laser acupuncture as an intervention for lateral epicondylalgia	Three studies (RCTs) examined the effect of laser acupuncture versus sham acupuncture on the same acupuncture points.	Pain, strength, self-report measures	Three studies used laser acupuncture while 6 used manual acupuncture. Low-quality evidence demonstrated that manual acupuncture may be effective in short-term pain relief (OR = 2.20; 95% CI: 1.51, 3.21) but there is no evidence that laser acupuncture provides an analgesic effect. Laser acupuncture did not make a substantial difference in treatment outcomes, and the exact treatment methods were unclear.
Bisset et al (2011)	Systematic review	Level of evidence = II AMSTAR = 7/11	Systematic reviews of RCTs and RCTs in any language on the effects of treatments for tennis elbow	Two systematic reviews and 6 RCTs comparing different intensity laser therapy regimens versus placebo	Pain, global improvement, functional improvement	Conflicting data and heterogeneity between studies suggests caution when drawing conclusions; however, a 904-nm wavelength over the tendon area may be effective in reducing pain and improving functional outcomes in the short term.
Tumilty et al (2010)	Systematic review	Level of evidence = II AMSTAR = 7/11	Randomized controlled trials and controlled clinical trials of low-intensity laser treatment administered to patients diagnosed with tendinopathy and assessing pain or functional outcomes.	Twenty-five trials were included in the review, and 22 were randomized controlled trials.	Grip strength, pain	Six studies yielded a positive effect of low-intensity laser on pain reduction and 7 studies reported no effect or inconclusive evidence related to pain reduction with the use of low-level laser treatment for LET. The authors were able to pool data related to grip strength using higher-quality studies (≥6 on PEDro scale; n = 4). Overall, the grip strength of the participants receiving low-intensity laser therapy demonstrated a final grip strength that was 9.59 kg (95% CI: 5.90, 13.27) greater than the control group participants. Of those studies that demonstrated a positive effect (12 out of the 13), the parameters used included a 904-nm wavelength and between 2-100 mW/cm^2 power density. Low-intensity laser treatment was potentially effective in treating tendinopathy using recommended doses, but the overall evidence was inconclusive.

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APPENDIX E (CONTINUED)

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Bisset et al (2005)	Systematic review	Level of evidence = II AMSTAR = 7/11	Randomized controlled trials that had participants diagnosed with lateral epicondylitis, which was defined as lateral elbow pain that increased on palpation and/or during resisted wrist extension, where at least one intervention included a relevant physical intervention.	Twenty-eight trials were included in the review, and 6 included a laser intervention.	Pain, grip strength, global improvement	When comparing laser to a placebo treatment, change in global improvement was not statistically significant (RR, 1.09; 95% CI: 0.77, 1.53) at 3-month follow-up. At 1-year follow-up, global improvement score change was approaching but did not reach statistical significance (RR, 1.52; 95% CI: 0.97, 2.38). Pooled data showed a null summated treatment effect on pain, grip strength, or global improvement in the treatment of lateral epicondylitis.

Abbreviations: ECRB, extensor carpi radialis brevis; ES, effect size; LET, lateral elbow tendinopathy; LLLT, low-level laser treatment; PCS, physical component summary; PRTEE, Patient-Rated Tennis Elbow Evaluation; RR, relative risk; SMD, standardized mean difference; US, ultrasound; VAS, visual analog scale.

Evidence Table: Ergonomics

Study	Type of Study	Evidence Rating and Critical Appraisal Score	Conditions	Sample Characteristics	Outcome Measures	Important Results
Tran et al (2021)	RCT	Level of evidence: II PEDro score: 7/10	Injured workers with a diagnosis of acute or chronic unilateral LET who had a current worker's compensation claim.	Forty-nine workers were randomized into either a standardized hand therapy group (n = 25) or an intervention group (n = 24) who received hand therapy plus a workplace-based education intervention. Hand therapy consisted of 10 sessions over 12 weeks. The education intervention consisted of 2 additional sessions consisting of education, assessment, and work modifications according to the identified occupational risk factors.	Pain (NPRS), PFGS with elbow flexed and extended, and function (PRTEE).	There were no statistically significant differences in improvement between groups for pain, PFGS, or function ($P>.05$) The investigators used an intension to treat analysis that included 6 individuals who did not receive the allocated education intervention.
Dick et al (2011)	Systematic review	Level of evidence: II AMSTAR score: 6/11	Looking at workplace interventions effective at preventing/reducing sickness/absence. Only 4 pathologies looked at carpal tunnel syndrome, nonspecific arm pain, tenosynovitis, and lateral epicondylitis	Twenty-eight papers were reviewed but only four were used for guideline recommendations: carpal tunnel (9 papers reviewed), nonspecific arm pain (15 papers reviewed), tenosynovitis (1 paper reviewed), lateral epicondylitis (1 paper reviewed)	Employment outcomes- absence rates, rate of return to work	Limited evidence that computer keyboards with altered force displacement or altered geometry help nonspecific arm pain. Limited evidence on the usefulness of modified keyboards. LET: not enough quality evidence on workplace management. Multidisciplinary approach is beneficial.

Abbreviations: LET, lateral elbow tendinopathy; NPRS, numeric pain-rating scale; PFGS, pain-free grip strength; PRTEE, Patient-Rated Tennis Elbow Evaluation; RCT, randomized clinical trial; VAS, visual analog scale.