# Lateral Epicondyle Tendinopathy - Details of Articles

*Developed by the BC Physical Therapy Tendinopathy Task Force: Dr. Joseph Anthony, Dr. Angela Fearon, Diana Hughes, Carol Kennedy, Dr. Alex Scott, Michael Yates, Alison Hoens. June 2013.*
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| Study | Type of Evidence | Methods | Results | Implications for Practice |
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| **MANUAL THERAPY** | | | | |
| ***Soft tissue techniques*** | | | | |
| Verhaar JAN, et al. Local corticosteroid injection versus cyriax-type physiotherapy for tennis elbow. *Journal of Bone and Joint Surgery*. Jan 1996; British 78B(1): 128-132. | RCT | *n=106 (mean (sd) age: 43 (9)).*<br>Mean duration of symptoms = 33 weeks.<br>Population: Outpatient setting.<br>Inclusion criteria included: Pain over the lateral aspect of the elbow, tenderness over the forearm extensor origin, and pain with resisted wrist extension.<br>Exclusion criteria included: elbow surgery, >3 CSI in the last 6 months, elbow arthritis or previous Cyriax-type physiotherapy treatment.<br>***2 groups:***<br>1. CSI (up to 3 injections).<br>2. Cyriax-type physiotherapy (DTFM and Mill's manipulation) 12 sessions over 4 weeks.<br>Follow up at 6 weeks and 1 year.<br>If treatment was unsuccessful at 6 weeks it was discontinued and an alternative treatment, including surgery, applied. | Cyriax-type physiotherapy was less effective than CSI at 6 weeks for grip strength, pain with resisted movements and overall satisfaction, but equivocal at 1 year with both groups showing improvements on these measures.<br>After 6 weeks, approximately 50% of both groups went on to have additional treatments: Additional Injection and / or Cyriax- type physiotherapy therapy (20% combined therapy); 32.1 % of CSI group and 26.4 % Cyriax group had surgery<br>Results included in the systematic review by Trudel at al., 2004 & Herd and Meserve, 2008. | From this study, no conclusion can be drawn about the long-term benefit or otherwise of Cyriax-type physiotherapy vs. CSI<br>More recent studies (Bisset et al, 2006) suggest that CSI is unlikely to be effective in the long term. As these two treatments had equivocal results at 12 months, this could suggest that Cyriax-type physiotherapy may not have a positive long-term effect.<br>It is worth noting that the authors report that patients with cervical spine symptoms at the start of the study were associated with poorer outcomes in both groups. |
| Brosseau L, Casimiro L, Milne S, et al. (2002). Deep transverse friction Tendinitis massage for treating tendinitis. *Cochrane Databse Syst Rev. 4.* | SR | MEDLINE, EMBASE, HealthSTAR, Sport Discus, CINAHL, the Cochrane Controlled Trials Register, PEDro, were searched up to June 2002. Reference lists were also scanned for additional studies. Data extracted and methodological quality was assessed. | Only two studies were found; one was relevant to LET. For the extensor carpi radialis tendonitis the results showed no improvement in pain or function after 9 sessions of DTFM. | From this study, no conclusions can be made on the effectiveness of DTFM for treatment of LET. The authors suggest other treatments such as correcting biomechanics and strengthening maybe more effective than DTFM. |

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| Law LAF, et al. Massage reduces pain perception and hyperalgesia in experimental muscle pain: A randomized, controlled trial. *Journal of Pain.* Aug 2008; 9(8): 714-721. | RCT | Acute muscle pain model (DOMs) was used to assess the immediate effect of deep tissue and superficial massage.<br><br>Population: 43 (females = 21, mean (SD) age: 23.3 (3.5)).<br><br>Inclusion criteria included: Not reported.<br><br>Exclusion criteria included: Any report of pre-existing of musculoskeletal pain.<br><br>***3 groups:***<br><br>1. Control (rest, no massage), n=11.<br>2. Superficial massage, n=17.<br>3. Deep tissue massage, n=16.<br><br>All participants had a session of exercise and a session of "treatment." Outcomes were measured immediately post treatment. | Massage did not change peak torque, or pain at rest.<br><br>Deep tissue massage had a greater influence on pain reduction than superficial massage for stretch pain.<br><br>Deep and superficial massage reduced mechanical hyperalgesia.<br><br>There was not difference between the results for men and women. | Extrapolation from this study may support the use of deep and superficial massage to alter muscle pain |
| Nagrale, A. et al. Cyriax physiotherapy versus phonophoresis with supervised exercise in subjects with lateral epicondylalgial [sic]. *Journal of Manual and Manipulative Therapy*. 2009; 17(3): 171-178. | RCT | *n=60 (mean age 38.6).*<br><br>***2 groups:***<br><br>1. Phonophoresis and exercise.<br>2. DTFM and Mill's manipulation.<br><br>3 sessions/week for 4 weeks.<br><br>Neither participant nor therapist were blinded, only the assessor.<br><br>Population: General public.<br><br>Inclusion criteria included pain with: palpation, resisted wrist extension, gripping, and passive wrist flexion. Duration of symptoms >4 weeks.<br><br>Exclusion criteria included: bilateral conditions, cervical radiculopathy, cortisone injection in last 6 months and nerve entrapment.<br><br>Outcomes measured at 2, 4 and 8 weeks. | Both groups had significant improvement in their outcome, with no between or within group differences. The DTFM/ Mill's manipulation group had better short-terms effects than the alternative treatment. In both groups there was a loss of improvement at the 8-week (final) follow up.<br><br>Results included in the systematic review by Joseph et al., 2012. | Both treatment approaches (DTFM/Mill's manipulation or phonophoresis/exercise) produced significant improvement, supporting their use in LET in the short term. |

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| Joseph M, Taft J, et al. Deep friction massage for the treatment of tendinopathy: A systematic review of a classic treatment in the face of a new paradigm of understanding. *Journal of Sports Rehabiliation.* 2012; 21: 343-353. | SR | Search of PubMed, Scopus, Pedro, CINAHL, PsycINFO, and Cochrane. No date or language limit.<br>Inclusions: Humans with tendon injuries.<br>Included: RCT, Comparison trials, and prospective non comparison trials.<br>Excluded: Review articles, papers with no outcomes, non-research articles, and non-tendinopathy papers.<br>Outcomes: Pain reduction, measures of function.<br>Quality rated via PEDro and Centre for evidence based medicine rating score. | 9 studied were included in the review.<br>4 RCTs (3 on LET), 2 non-randomized studies (both on LET), and 3 prospective non-comparison studies (1 on LET).<br>DTFM was less effective than CSI at 6/52, but equivocal at 12/12.<br>Non-RCTs concluded that DTFM helpful. | Overall synthesis suggests DTFM is effective when used in conjunction with other techniques.<br>The review includes studies for tendons other than LET and includes trials from 1982 and 1992 which have not been reviewed in this current paper. |
| Viswas R, Ramachandran R, Korde Anantkumar P. Comparison of effectiveness of supervised exercise program and cyriax physiotherapy in patients with tennis elbow (lateral epicondylitis): a randomized clinical trial. *The Scientific World Journal.* 2012. | RCT | n=20 (10 in each group, mean (sd) age 37.8 (4.61)).<br>***2 groups:***<br>1. Supervised exercise.<br>2. Cyriax-type physiotherapy (DTFM and Mill's manipulation).<br>Population: Outpatient setting.<br>Blinding was of assessors only.<br>Symptom duration = 8 to 10 weeks.<br>Inclusion criteria: pain with gripping, resisted wrist extension, stretch, palpation.<br>Exclusion criteria included: Previous manual therapy, nerve entrapment and elbow pain.<br>Follow up was at 4 weeks post intervention. | Both groups had significant improvement in pain and function at 4 weeks.<br>The exercise group had significantly better outcomes for both pain and function. | Although both groups did achieve improved outcomes, the exercise group obtained superior results.<br>*Note: The exclusion criteria of elbow pain, was presumably elbow joint pain so that the Mill's manipulation would not be contra-indicated.* |

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| Ajimsha, MS, Chithra, S, Thulasyammal, RP. Effectiveness of Myofascial Release in the Management of Lateral Epicondylitis in Computer Professionals. *Archives of Physical Medicine & Rehabilitation*. 2012; 93(4): 604-609. | RCT | *n=68 (mean (sd) age: 29.9 (4.9).*<br>***2 groups:***<br>1. Myofascial release (+ therapist contact).<br>2. Sham US (+therapist contact).<br>Blinding of assessors.<br>Population: Computer professionals.<br>Inclusion criteria included: Pain for ≥1 day in the last 7; duration of symptoms >3 months; pain over the lateral aspect of the elbow; and pain with resisted wrist extension.<br>Exclusion criteria included: analgesic use on >10 days in one month; elbow instability, trauma or surgery; systemic use of steroids; or cervical spine pathology.<br>Outcomes measures at 4 and 12 weeks post intervention. | Participants in the myofascial release group had a greater reduction in pain and functional disability than those in the sham US group at the 4 week and the 12 week reviews. | Myofascial release was found to be more effective than sham US at 4 and 12 weeks post treatment. |
| ***Elbow MWM*** | | | | |
| Vicenzino, B. et al. Specific manipulative therapy treatment for chronic lateral epicondylalgia produces uniquely characteristic hypoalgesia. *Manual Therapy*. Nov 2001; 6(4): 205-212. | RCT | *n=24 (F=10).*<br>***3 groups:***<br>1. MWM.<br>2. Sham.<br>3. Control.<br>Population: General public.<br>Inclusion criteria included: lateral epicondyle tenderness; pain with resisted wrist extension and grip; duration of symptoms: >6 weeks.<br>Exclusion included: Neck and other upper limb problems, anti-inflammatory drugs, recent cortisone injection. | Elbow MWM produces a period of increased PFGS and PPT during and following its application.<br>Results included in the systematic review by Bisset et al., 2005 | This early RCT found positive immediate response to elbow MWM in subjects with LET, as measured by PFGS and PPT. |

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| Kocha, M, Dogra, A. Effectiveness of a specific physiotherapy regime on patients with tennis elbow: Clinical study. Physiotherapy, 2002; 88(6): 333-341. | RCT | ***3 groups:***<br>1. Control.<br>2. Elbow MWM + US.<br>3. US alone (3 MHz, 1.5 W/cm2 pulsed).<br>After 3 weeks of twice weekly treatment, both treatment groups completed a 9-week progressive home exercise program (stretching, isometric, concentric, and eccentric).<br>Inclusion criteria included: lateral epicondyle tenderness; pain with resisted wrist extension and grip.<br>Symptom duration: 15 days to 12 months.<br>Exclusion: cervical nerve entrapment, CSI in last 6 months.<br>Follow up was at 12 weeks. | At 12 weeks, both treatment groups showed superior results to the control group. The MWM/US group was superior to both other groups at an earlier point in follow-up and obtained better outcomes overall.<br>Results included in the systematic review by Herd and Meserve, 2008 & Vicenzino et al., 2007. | Combining elbow MWM with a multimodal treatment of US and progressive exercise resulted in earlier and increased improvement of LET, which was maintained at 12 weeks. |
| Paungmali, A et al. Hypoalgesic and sympathoexcitatory effects of mobilization with movement for lateral epicondylalgia. *Physical Therapy.* Apr 2003; 83(4): 374-383. | RCT | *n=24 (F=7).*<br>***3 groups:***<br>1. MWM.<br>2. Sham.<br>3. Control.<br>Evaluated:<br>Pain outcomes – PFGS, PPT.<br>Sympathetic nervous system activity – heart rate, blood pressure, sudomotor and vasomotor activity.<br>Population: General public, mean duration 8.5 months. Inclusion criteria included: lateral epicondyle tenderness, pain with resisted wrist extension and grip.<br>Exclusion included: Neck and other upper limb problems, anti-inflammatory drugs, recent cortisone injection.<br>Outcomes measured immediately post treatment. | MWM resulted in increased PFGS and PPT. Thermal pain threshold did not change. There were sympathetic nervous system excitatory changes associated with MWM but not with the sham or control treatments.<br>Results included in the systematic review by Bisset et al, 2005 & Herd and Meserve, 2008. | The aim of this study was to explore the physiological effects of a manual therapy technique and the possible mechanisms.<br>This study showed immediate improvement in pain measures following elbow MWM for LET.<br>Potential mechanisms were a change in mechanical pain thresholds (not thermal) and an excitatory sympathetic nervous system response. |

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| Bisset L, Paungmali A, Vicenzino B, Beller E. A systematic review and meta-analysis of clinical trials on physical interventions for lateral epicondylalgia. *British Journal of Sports Medicine.* 2005; 39, 411-422. | SR | Medline, CINAHL, Embase, Web of Science; Allied health and Complimentary Medicine, SportDiscus, and PEDro. Cochrane Controlled Trial Register. | No long-term studies of adequate quality. There is some evidence for initial positive effect on elbow MWM. | This early SR found no high quality long term studies to support the use of manual therapy, although there was some support for immediate positive effects. |
| Bisset L, Beller E, Jull G, Brooks P, Darnell R, Vicenzino B. Mobilisation with movement and exercise, corticosteroid injection, or wait and see for tennis elbow: randomised trial. *British Medical Journal*. Nov 4, 2006; 333(7575): 939-941. | RCT | *n=198.*<br>Duration of symptoms: >6/52.<br>Inclusion criteria included: lateral epicondyle tenderness, pain with resisted wrist extension and grip.<br>Exclusion: any elbow treatment by a health professional in the last 6/12, nerve entrapment.<br>***3 groups:***<br>1. Physiotherapy group (PT) = MWM and exercise.<br>2. CSI = up to three injections.<br>3. "Wait and see" = Advice.<br>Follow up was at 3, 6, 12, 26, and 52 weeks. | At 6 weeks: CSI group had better outcomes than PT or "wait and see."<br>PT better than "wait and see."<br>At 52 weeks: the CSI group had worse outcomes than PT or "wait and see" groups. There was no difference between the PT and "wait and see."<br>CSI group had most recurrences.<br>Results included in the systematic review by Barr et al, 2009 | Although CSI did show superior outcomes at 6 weeks, in the long term (1 year), both elbow MWM + exercise or "wait and see", was found to be superior to CSI. CSI resulted in the worst outcomes and highest recurrence rates at 1 year.<br>The PT group sought significantly less other treatment, and was superior to "wait and see" at 6 weeks. |
| Vicenzino B, Teys PA. Mulligan's mobilization-with-movement, positional faults and pain relief: Current concepts from a critical review of literature. *Manual Therapy.* 2007; (12): 98-108. | Lit review | Narrative review of the literature on MWM techniques in general included a total of 9 clinical and 10 laboratory studies.<br>Of these 19 studies, 9 were for LET: 3 RCTs, 1 quasi RCT, 1 case study, 2 case series, 1 randomized crossover and 1 repeated measures design. | The 9 studies on the use of MWM for LET included in this review reported positive findings, mostly on the short term for improvements of PFGS and PPT. Many of these studies are reported elsewhere in this document. | This literature review, although not as rigorous as a systematic review, outlines the positive findings with the use of elbow MWM as part of a multimodal treatment for LET.<br>Of note, when using elbow MWM, pain reduction should be apparent with the first treatment. |

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| Barr S, Cerisola F, Blanchard V. Effectiveness of corticosteroid injections compared with physiotherapeutic interventions for lateral epicondylitis: A systematic review. *Physiotherapy.* Dec 2009; 95(4): 251-265. | SR | A comprehensive search of Medline, CINAHL, AMED, SPORTDiscus, EBSCOhost and PEDro ending in week 12 2009). Evaluated all English language RCTs that compared CSI with physiotherapeutic interventions, with one relevant outcome measure.<br>A total of 5 RCTs were evaluated.<br>Physiotherapy interventions included US, electrotherapy, frictions, taping, acupuncture, mobilization, manipulation, exercise, home exercise and Mill's manipulation. | Large effects sizes were found for CSI in the short term.<br>At intermediate and long term, medium to large effect sizes supported physiotherapy interventions over CSI | Although CSI produces superior results in the short term, intermediate and long term outcomes favour physiotherapy interventions.<br>However the limited number of high quality studies and the multitude of interventions included make it difficult to draw more specific conclusions. |
| Pagorek S. Effect of manual mobilization with movement on pain and strength in adults with chronic lateral epicondylitis. *Journal of Sport Rehabilitation*. 2009; 18(3): 448-457. | Critically appraised topic | Examination of specific literature based on a specific clinical question. This means the literature selected had to meet specific inclusion and exclusion criteria -related to the clinical situation, in this case, an adult with chronic lateral epicondylitis. | 9 articles were reviewed: 3 systematic reviews, 2 RCTs, 2 cohort studies, 1 each of case study and expert opinion.<br>All studies reported on elbow MWM, and found that MWM reduced pain and increased strength. | This critically appraised topic, although not as rigorous as a SR, supports the use of elbow MWM as part of the treatment plan for LET. |
| Bisset L, Coombes B, Vicenzino B. Tennis elbow. *Clinical Evidence*. June 2011. Doi.pii:1117 | SR | Medline 1966 to November 2009, Embase 1980 to November 2009, and The Cochrane Database of Systematic Reviews 2009, Issue 4.<br>This paper attempted to answer the question: "What are the effects of treatments for tennis elbow?" | This review reports on a number of RCT's, covering multiple types of treatment for LET.<br>There is low quality evidence to support the use of manual therapy - specifically elbow manipulation (MWM) and DTFM | This recent SR "categorizes manipulation as unknown effectiveness as there is insufficient good quality evidence to assess the effects on tennis elbow"<br>This review did not include any studies on cervical spine treatment for LET. |
| Trudel D, Duley J, Zastrow I, et al. Rehabilitation for patients with lateral epicondylitis: a systematic review. *Journal of Hand Therapy.* 2004; 17(2): 243-266. | SR | Search of Medline, CINAHL, EMBASE, PEDro and Cochrane. Systematic review with meta-analysis.<br>31 studies were included. | There was Level 2b evidence that manual therapy along with acupuncture, exercise, US and others, give positive results for pain and function in LET. | This SR suggested the use of interventions that demonstrated strongest evidence of effect, including manual therapy, for the treatment of LET.<br>They also suggest that given the lack of conclusive evidence, that clinical reasoning and experience must be utilized to develop an appropriate treatment plan. |

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| ***Wrist MWM*** | | | | |
| Struijs, PAA, et al. Manipulation of the wrist for management of lateral epicondylitis: A randomized pilot study. *Physical Therapy*. July 2003; 83(7): 608-616. | RCT – pilot | *n=31*<br>***2 groups:***<br>1. MWM of the wrist.<br>2. Multimodal (US, DTFM, stretching, strength).<br>Population: General practice patients.<br>Inclusion criteria included: >6 weeks to 6 months duration.<br>Exclusion criteria included: Severe neck or shoulder problems.<br>Outcomes measured at 3 and 6 weeks post intervention. | Wrist manipulation was more effective than the multimodal intervention in the short term for global improvement at 3 weeks and for pain scores at 6 weeks.<br>Results included in the systematic review by Bisset et al, 2005 & Herd and Meserve, 2008. | It may be beneficial to assess and treat any wrist involvement in patients with LET.<br>The results of this study need to be replicated in a larger RCT. |
| ***Spinal Manual Therapy*** | | | | |
| Vicenzino B, Collins D, Wright A. The initial effects of a cervical spine manipulative physiotherapy treatment on the pain and dysfunction of lateral epicondylalgia. *Pain.* Nov 1996; 68(1): 69-74. | RCT | *n=15 (8 females and 7 males). Mean age 44 (range 22.5 to 62 years).*<br>***Treated over 3 days with one each of:***<br>1. Cervical mobilization.<br>2. Placebo.<br>3. Control.<br>Inclusion criteria: tenderness on palpation, pain on stretch, pain on resisted extension or grip.<br>Exclusion: Subjects with past cervical spine treatment.<br>14/15 had hypomobile cervical joints (was not part of inclusion criteria).<br>Treatment:<br>Cervical spine mobilization: Gr III passive contralateral lateral glide mob to C5/6 with affected limb in some neurodynamic tension.<br>This covered only 1 treatment, and the immediate effect (ULNT, PFG, PPT, 24-hr pain scores, 24-hr function VAS). | Positive short-term (immediate and at 24 hours) results.<br>The cervical manual therapy intervention showed significant improvement in PPT, PFGS, ULNT & pain scores but not 24-hr function, compared to control and placebo groups (P=.05)<br>Results included in the systematic review by Bisset et al, 2005 & Herd and Meserve, 2008. | The aim of this study was to investigate the immediate and 24 hour effects of manual therapy on pain and function using LET as the pain model.<br>The results found an immediate hypoalgesic response to cervical lateral glide mobilization.<br>Long-term effects were not investigated, but the improvement was maintained at 24 hours. |

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| Cleland JA, Whitman JM, Fritz, JM. Effectiveness of manual physical therapy to the cervical spine in the management of lateral epicondylalgia: a retrospective analysis. Commentary by Vicenzio B. *Journal of Orthopaedic & Sports Physical Therapy.* 2004; 34(11): 713-724. | Chart review<br>Retrospective ex-post facto design | 112 records reviewed.<br>Selection criteria: Two or more of the following: pain during palpation of the lateral epicondyle, pain with resisted wrist extension, or pain with resisted middle finger extension.<br>The decision to include cervical spine treatment was based on the discretion of therapist that cervical dysfunction was present.<br>Only 3 patients reported cervical symptoms on initial assessment.<br>***2 groups:***<br>1. Those who had local treatment to the elbow.<br>2. Those who had the addition of cervical spine mobilization. | Both groups showed high levels of success (elbow group 75%, cervical group 80%). Those who had cervical spine treatment required fewer treatments (5.6 vs. 9.7).<br>Treatments used:<br>80% passive mobilization<br>52% muscle energy techniques<br>30% cervical spine MWM.<br>Results included in the systematic review by Herd and Meserve, 2008. | Although local treatment alone was successful in the management of LET, the addition of cervical spine manual therapy obtained a more efficient response, requiring fewer visits to resolve.<br>Of interest is that the group that received cervical spine manual therapy also received more elbow mobilization and so this may also be a factor in the between group difference.<br>As the majority of subjects did not report cervical involvement, a full cervical assessment should be considered to determine if cervical treatment should be included in the management of LET. |
| Cleland JA, Flynn TW, Palmer JA. Incorporation of manual therapy directed at the cervicothoracic spine in patients with lateral epicondylalgia: a pilot clinical trial. *Journal of Manual & Manipulative Therapy.* 2005; 13(3): 143-151. | RCT – pilot study | *n=10, randomly assigned to either.*<br>***2 groups:***<br>1. Local treatment (stretch, concentric and eccentric exercise, joint mobs to wrist and elbow).<br>2. Local + spinal treatment. (Cervical and thoracic Maitland grade III and IV passive physiological and accessory. No grade V manipulative thrusts. Applied as per findings on initial evaluation).<br>Inclusion: signs of LET and articular impairments of cervical or thoracic spine.<br>Treated 10 times over 6 weeks.<br>Outcomes: NPRS, PFGS, DASH, global rating of change | 9/10 participants had a good outcome at discharge and 6-month follow-up. The group that had the spinal combined treatment did better in all outcomes as compared to the group who only had local treatment.<br>Results included in the systematic review by Herd and Meserve, 2008. | This pilot study showed that the addition of cervical manual therapy to local elbow treatment was superior to local treatment alone.<br>Unlike most of the other studies of only immediate results, these positive results were found to be maintained for both the intermediate and long term (6 months).<br>None of the subjects reported any neck pain even though cervical dysfunction was found on assessment, again suggesting the need for a cervical screening exam for LET patients regardless of the presence of neck pain. |

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| Fernández-Carnero J, Fernández-De-Las-Peñas C, et al. Immediate hypoalgesic and motor effects after a single cervical manipulation in subjects with lateral epicondylalgia. *Journal of Manual & Manipulative Therapy.* 2008; 31(9): 675-681. | Repeated measures, crossover, single-blinded randomized study | *n=10 (5M, 5F), 30-49 years old.*<br>*Measured PFG, PPT, C/HPT.*<br>***2 groups:***<br>1. Cervical manipulative thrust (gr V).<br>2. Manual contact intervention.<br>Immediate results were measured at 5 minutes. | The manipulation group showed: greater bilateral increased in PPT, increased PFG on the effected side, but no change in C/HPT. | Immediate improvement in LET pain can be achieved using a cervical spine manipulative thrust technique. |
| Fernández-Carnero J, Cleland A. Examination of motor and Hypoalgesic Effects of cervical vs thoracic spine manipulation in patients with lateral epicondylalgia: A clinical trial. *Journal of Manual & Manipulative Therapy.* 2011; 34(7): 432-440. | RCT | *n=18.*<br>***2 groups:***<br>1. Cervical manipulation (C5/6 on affected side).<br>2. Thoracic manipulation (stiff level between T5-8).<br>Single blind.<br>Measured PPT, PFGS pre-intervention and 5 minutes post.<br>Patients were excluded if there were contraindications to or treatment of cervical or thoracic spine in the last 12 months. | Cervical manipulation showed greater increase in PPT over thoracic manipulation.<br>Manipulation resulted in increased PFGS, but there was no significant difference between groups. | PPT and PFGS improves following either cervical or thoracic manipulative thrust techniques (grV), but cervical manipulation was superior over thoracic for the PPT.<br>These results were found only as immediate responses; longer term effects are yet to be investigated. |

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| ***SR/MA evaluating various interventions and regions*** | | | | |
| Smidt N. et al. Effectiveness of physiotherapy for lateral epicondylitis: a systematic review. *Annals of Medicine.* 2003; 35(1): 51-62. | SR | Medline. CINAHL, Embase, Cochrane collaboration trail register, current contents and reference lists were searched. For the study to be included, treatments had to be compared to placebo, no treatment or another conservative treatment – not surgery. Trials had to be randomized, and at least one clinical outcome had to be reported. Data pooling for manual therapy techniques was not possible. Trials were assessed for quality. | Most studies included a mix of duration of symptoms, that is, acute and chronic.<br><br>11 studies excluded those with neck pain, One study explicitly included neck pain, seven didn't specify.<br><br>Inconsistent use of outcome scores, with most not blinded.<br><br>None of the studies had adequate power to demonstrate a standardised mean difference (SMD).<br><br>Synthesis of the data found insufficient evidence for exercise or mobilization techniques.<br><br>One study with acceptable validity found exercise to be more beneficial than combined US and frictions.<br><br>Some, but not all, of the papers covered in this review are included in the systematic review by Bisset et al 2005. | This early SR found insufficient evidence for exercise and mobilization techniques due to poor methodology of included studies. |

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| Bisset L, Paungmali A, Vicenzino B, Beller E. A systematic review and meta-analysis of clinical trials on physical interventions for lateral epicondylalgia. *British Journal of Sports Medicine.* July 1, 2005; 39(7): 411-422. | SR and MA | Medline, CINAHL, Embase, Web of Science, Allied and Complimentary Medicine, SPORTDiscus, and PEDro, without language restrictions, using the recommended Cochrane Library search strategy. The Cochrane Controlled Trial Register was searched for RCTs on LET/tennis elbow, and references from retrieved articles and systematic reviews were also screened. Papers were assessed for quality using a modified PEDro score. Papers had to score ≥8/15 to be included.<br><br>Data pooling for elbow manipulation.<br><br>*Note: While the term manipulation is used here, the description in both studies is a mobilization (<grade 5).* | Elbow MWM: Two studies of adequate quality looked at elbow mobilization/manipulation and found good evidence for short-term effects (<6 weeks).<br><br>Wrist manipulation: No difference was seen between groups that had wrist manipulation vs. multimodal treatment of DTFM/US/exercise: both groups had a similar proportion of participants report improvements.<br><br>Cervical Spine Mobilization: There are no long-term studies that evaluate the effectiveness of mobilization/ manipulation. The one study reported evaluated only one treatment, and the immediate effect – that is, no medium- or long-term outcomes. It did deliver immediate pain relief.<br><br>Multimodal (Massage +US + exs) had better long-term effect than CSI. Trend to better than wait and see, but not statically. | "In summary, there are no long-term studies of adequate methodological quality on manual therapy. However, there appears to be some evidence of positive initial effects in favour of elbow manipulative therapy techniques that suggests the need for further research." |

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| Herd CR, Meserve BB. A systematic review of the effectiveness of manipulative therapy in treating lateral epicondylalgia. *Journal of Manual & Manipulative Therapy.* 2008; 16(4): 225-237. | SR | A comprehensive search of Medline, CINAHL, Health Source, SPORTDiscus, and the PEDro ending in November 2007. 13 studies were evaluated (both RCT and Non-RCT).<br>There is some duplication of articles reviewed within this and other review articles. | There is good clinical evidence to support the use of MWM to the elbow for short and long-term results.<br>There is poor through to high quality evidence supports the use of cervical mobilization in addition to local treatment.<br>There is conflicting evidence about the effectiveness of Cyriax regime.<br>One high quality pilot study supports the use of radial head mobilization and neural tension work | Several high quality studies support the use of elbow MWM.<br>Evidence suggests including cervical and /or thoracic treatment in addition to elbow treatment, in those with signs (not necessarily symptoms) of cervical and/or thoracic dysfunction<br>DTFM along with Mill's manipulation might be of benefit within a multimodal approach.<br>In assessing a patient with LET, consider the possible involvement of aberrant radial head mechanics and abnormal neurodynamics and if these are present, radial head mobilization and neurodynamic techniques may be of benefit. |
| Gonzalez-Iglesias J, Cleland JA, Gutierrez-Vega M, Fernandez-de-las-Penas C. Multimodal Management of Lateral Epicondylalgia in Rock Climbers: A Prospective Case Series. *Journal of Manipulative & Physiological Therapeutics.* 2011; 34(9): 635-642. | Case series<br>(acute, mean duration = 3 weeks) | *Rock climbers, N=9 (F=3), age range 17 to 36.*<br>Outcomes: PPT, PRTEE.<br>Multimodal (cervical and thoracic spine manipulation, elbow MWM, manipulation of the wrist, trigger point dry needling and kinesio tape, stretching). Follow up = 8 weeks. | All outcome measures improved with this multimodal approach, no statistical analysis was undertaken by the authors. | This case series demonstrates the potential success of a multimodal approach to treatment of LET. |

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| Study | Type of Evidence | Methods | Results | Implications for Practice |
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| **EXERCISE** | | | | |
| Croisier JL, Foidart-Dessalle M, Tinant F, Crielaard JM, Forthomme B. An isokinetic eccentric programme for the management of chronic lateral epicondylar tendinopathy. *British Journal of Sports Medicine.* 2007; 41(4): 269-75. | OS | Patients were not randomly assigned but matched for age, gender and activity with the control group. A passive standardized rehabilitation program was compared to the same program with the addition of eccentric exercises on a Cybex machine.<br>***2 groups:***<br>1. Passive standardized rehabilitation program (control) n=46.<br>2. Passive standardized rehabilitation program with eccentric ex using Cybex *n=46.*<br><br>12 patients in the eccentric group did not complete the program in the required time of 9 weeks. | Eccentric exercise group improved in strength, disability status, pain intensity and tendon imaging.<br>Results included in the systematic review by Raman et al. (2012) | This study provides evidence that an eccentric exercise program on a cybex machine is more effective than a "passive rehabilitation program." |
| Luginbühl R, Brunner F, Schneeberger AG. No effect of forearm band and extensor strengthening exercises for the treatment of tennis elbow: a prospective randomised study. *La Chirurgia degli Organi di Movimento.* 2008; 91(1): 35-40. | RCT | ***3 groups:***<br>1. Grip and extensor strengthening exercise group (concentric and eccentric).<br>2. Forearm support band.<br>3. Both strengthening and support band.<br><br>All had an injection of Trimecalone to start. Patients were instructed to not exercise into pain and to wear the forearm support band while performing the exercise. 29 patients with 30 tennis elbows completed the trial. 6 had been lost to follow up. | No difference was found between the three groups at one year follow up. All had improved.<br>Results included in the systematic review by Raman et al. (2012) | It is surprising that there was no difference between the exercise group and the forearm support band group as other studies (Struijs, 2004, Sölveborn, 1997.<br>See "Details of Articles" – bracing) have found exercise to be superior to a forearm support band. Perhaps the improvement in the exercise group was limited by the instruction not to exercise into pain and/or by the wearing of the brace during exercise. |

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| Martinez-Silvestrini JA, Newcomer K L, 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. Journal of Hand Therapy, 2005. Oct-Dec; 18(4): 411-419. | RCT | ***3 groups:***<br>1. Stretching n=33.<br>2. Concentric strengthening with stretching n=30.<br>3. Eccentric strengthening with stretching n=31, using resistance bands.<br><br>14% of participants had dropped out at 6 weeks. The dropout rate was not statistically significant. | All groups improved at 6 weeks. No significant difference between groups.<br><br>Results included in the systematic review by Raman et al. (2012). | This study suggests that all exercise whether it is stretching, concentric or eccentric strengthening is equally effective at least in the short term. |
| Nilsson P, Thom E, Baigi A, Marklund B, Mansson J. A prospective pilot study of a multidisciplinary home training program for lateral epicondylosis. *Musculoskeletal Care.* 2007; 5(1):36-50. | OS | *Prospective non-randomized trial.*<br><br>***2 groups***:<br>1. Specific home exercise program, ergonomic advice and when necessary wrist and/or night bandages (n=51).<br>2. Corticosteroid injections, stretching or no intervention (n=27).<br><br>There was a 15% drop out rate for the intervention group, 55% for the control group. Included in the systematic review by Raman et al. (2012) | At 4 and 16 weeks the intervention group had less sick leave and better function than the control group. | This study suggests that exercise in the form of a home exercise program is effective in improving the outcome of LET. |
| Park JY, Park HK, Choi JH, Moon ES, Kim BS, Kim WS, Oh KS. Prospective evaluation of the effectiveness of a home-based program of isometric strengthening exercises: 12-month follow-up. (eng) *Clinics In Orthopedic Surgery*. ISSN: 2005-4408, Sep 2010; 2(3): 173-8. | RCT | ***2 groups:***<br>1. Pain-free isometric wrist extension in full wrist extension immediately (n=16).<br>2. Medication for 4 weeks before starting the exercises (n=15).<br><br>5 participants dropped out. | Outcome measures improved in exercise group at 4 weeks compared to control. No difference at 3, 6 and 12 months.<br><br>Results included in the systematic review by Raman et al. (2012). | Faster onset of favorable results if exercise is started immediately. |

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| Peterson M, Butler S, Eriksson M, Svardsudd K. A randomized controlled trial of exercise versus wait-list in chronic tennis elbow (lateral epicondylosis). *Uppsala Journal of Medical Science.* 2011; 116: 269-279. | RCT | ***2 groups:***<br>1. Exercise group concentric/eccentric wrist extension, 3X15 reps daily. Load increased 1/10th of a kilo weekly for 3 months. (n=40).<br>2. Control group – no treatment (n=41).<br><br>7% of participants dropped out of the exercise group, 10% in the control group. | The exercise group had a significantly greater and faster recovery, in terms of pain during maximum voluntary contraction and pain during maximum muscle elongation, than the reference group. There was also a non-significant trend towards less restricted arm activity and arm muscle strength in the exercise group. | Another article supporting the use of concentric/eccentric exercise. |
| Pienimaki TT, Tarvainen TK, Siira PT, Vanharanta H. Progressive strengthening and stretching exercises and ultrasound for chronic lateral epicondylosis. *Physiotherapy.* 1996; 82(9): 522-30. | RCT | ***2 groups:***<br>1. 6-8 weeks of exercise (n=20).<br>2. Ultrasound (n=19).<br><br>Exercises consisted of progressive slow, repetitive wrist and forearm stretching, muscle conditioning and occupational exercises. | Results indicated that progressive exercise therapy was more effective than ultrasound in treating chronic lateral epicondylitis.<br><br>Results included in the systematic review by Raman et al. (2012) | Exercise for 6-8 weeks rather than ultrasound for chronic tennis elbow is more effective. |
| Pienimaki T, Karinen P, Kemila T, Koivukangas P, Vanharanta H. Long-term follow-up of conservatively treated chronic tennis elbow patients. A prospective and retrospective analysis. *Scandinavian Journal of Rehabilitation Medicine.* 1998; 30: 159-166. | RCT | This study repeated the previous Pienimaki study (1996) but with long-term follow up. 23 of the original 39 participants responded to a mailed questionnaire. Exercise (n= 12), ultrasound (n=11). | The exercise group did significantly better than ultrasound group after a mean of 36 months. | 6-8 weeks of exercise compared to ultrasound is more effective for chronic tennis elbow even after a mean of 36 months. |
| Raman J, MacDermid J, Grewal R. Effectiveness of Different Methods of Resistance Exercises in Lateral Epicondylosis—A Systematic Review. *Journal of Hand Therapy.* Jan-Mar 2012; 25(1): 5-26. | SR | Data bases were searched from 1990-2010. Of the 12 studies, 9 addressed the effects of isotonic (eccentric/ concentric) exercises, 2 studied the effect of isometric and one studied isokinetic exercises. | The study concludes that "All the studies reported that resistance exercise resulted in substantial improvement in pain and grip strength; eccentric exercise was most studied. Strengthening using resistance exercises is effective in reducing pain and improving function for lateral epicondylosis but optimal dosing is not defined." | |

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| Stasinopoulos D, Stasinopoulos I. (2006) Comparison of effects of cyriax physiotherapy, a supervised exercise programme and polarized polychromatic non-coherent light (bioptron light) for the treatment of lateral epicondylosis. *Clinical Rehabilitation.* 20(1): 12-23. | CT | *Sequentially allocated to one of **3 groups** (n=25 each):*<br>1. Eccentric exercise plus extensor carpi radialis brevis (ECRB) stretching.<br>2. Cyriax physiotherapy.<br>3. Bioptron light.<br><br>All 75 original participants completed the trial. This study is included in the systematic review by Raman et al. (2012) | The supervised eccentric exercise program with ECRB stretching produced the largest effect in the short, intermediate and long term. | This study supports the use of a supervised eccentric exercise program with ECRB stretching rather than Cyriax physiotherapy or bioptron light. |
| Tyler T, Thomas G, Nicholas S, McHugh M. Addition of isolated wrist extensor eccentric exercise to standard treatment for chronic lateral epicondylosis: a prospective randomized trial. *Journal Of Shoulder And Elbow Surgery.* Sep 2010; 19(6): 917-922. | RCT | ***2 groups:***<br>1. Eccentric exercise group (n=11) using a Thera-Band FlexBar.®<br>2. Isotonic exercise group (n=10).<br><br>Both groups also had concurrent standard physiotherapy. There were no reported drop outs during the study. Included in the systematic review by Raman et al. (2012). | The FlexBar® exercise was prescribed 3x15 reps daily for approximately 6 weeks. Resistance was increased by using a thicker FlexBar® when the exercise no longer caused discomfort. All outcome measures were markedly improved at 7 weeks with the addition of the FlexBar® exercise. This was a small study with a high risk of bias. | This study supports the use of a Thera-Band FlexBar® to provide eccentric resistance training to the wrist extensors. |
| Viswas R, Ramachandran R, Korde Anantkumar P. Comparison of effectiveness of supervised exercise program and cyriax physiotherapy in patients with tennis elbow (lateral epicondylitis): a randomized clinical trial. *The Scientific World Journal.* 2012. | RCT | *n=20 (10 in each group, mean (sd) age 37.8 (4.61)).*<br>***2 groups:***<br>1. Supervised exercise.<br>2. Cyriax-type physiotherapy (DTFM and Mill's manipulation).<br>Population: Outpatient setting.<br>Blinding was of assessors only.<br>Symptom duration = 8 to 10 weeks.<br>Inclusion criteria: pain with gripping, resisted wrist extension, stretch, palpation.<br>Exclusion criteria included: Previous manual therapy, nerve entrapment and *elbow pain*.<br>Follow up was at 4 weeks post intervention. | Both groups had significant improvement in pain and function at 4 weeks.<br>The exercise group had significantly better outcomes for both pain and function. | Although both groups did achieve improved outcomes, the exercise group obtained superior results.<br>*Note: The exclusion criteria of elbow pain, was presumably elbow joint pain so that the Mill's manipulation would not be contra-indicated.* |

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| Study | Type of Evidence | Methods | Results | Implications for Practice |
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| **ACUPUNCTURE** | | | | |
| Trinh KV, Phillips SD, Ho E, Damsma K. Acupuncture for the alleviation of lateral epicondyle pain: a systematic review. *Rheumatology*. 2004; 43: 1085-90. | SR | Online bibliographic database searches in any language from Medline, PsychINFO, CINAHL, Healthstar, PMID, CAM, EMBASE, Cochrane Database of Systematic Review (3rd quarter 2003), articles listed in reference lists of key articles and the author's personal files were performed. | Study quality was determined by using the Jadad scale, in which all studies were rated as high quality. A best evidence synthesis approach was used to analyse the data presented in the 6 studies. All the studies suggested that acupuncture was effective in the short-term relief of lateral epicondyle pain. 5 of 6 studies indicated that acupuncture treatment was more effective compared to a control treatment. | Acupuncture appears to be effective in the short-term relief of lateral epicondyle pain.<br>*Note: 4 of the 6 studies specified that the condition was chronic. In the other 2, it was not specified.* |
| NIH Consensus Conference. November 4, 1998. Acupuncture. NIH Consensus Development Panel on Acupuncture. *Journal of the American Medical Association.* 1998; 280(17)1518-1524. | Consensus Conference | An expert panel appointed by the NIH synthesized available evidence and engaged in a consensus building process resulting in the formulation of the document. | Considerable evidence was summarized, leading to the conclusion that opiod peptides are released during acupuncture, and that the analgesic effects of acupuncture are partially explained by this effect. The definition and characterization of acupuncture points remains controversial, and traditional theories of acupuncture (e.g., Qi, energy) have not been reconciled with contemporary biomedical information. | It was concluded that acupuncture may be useful as an adjunct treatment or an acceptable alternative or be included in a comprehensive management program for tennis elbow. So-called nonspecific effects, which are sometimes seen even with sham acupuncture "account for a substantial proportion" of acupuncture's effectiveness, "and thus should not be casually discounted." |

| LOW LEVEL LASER THERAPY (LLLT) | | | | |
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| **Study** | **Type of Evidence** | **Methods** | **Results** | **Implications for Practice** |
| Bisset L, Coombes B, Vicenzino B. Tennis elbow. *Clinical Evidence.* 2011; 1-35. | SR | 2 SR (13 RCTs, 730 people and 6 RCTs, 277 people). | Moderate-quality evidence that LLLT seems more effective at reducing pain, increasing global improvement and improving pain-free grip strength after treatment, at up to 2 months, but no more effective in these areas at 3 months or more. | Overall, conflicting data and heterogeneity between RCTs suggests that caution should be taken in drawing conclusions regarding the effects of LLLT. However, it seems that LLLT using a 904-nm wavelength applied directly over the tendon area may be effective in reducing pain and improving functional outcomes in the short term in people with tennis elbow. |
| 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. *Photomedicine and Laser Surgery.* 2010; 28(3): 327-336. doi: 10.1089/pho.2009.2558 | SR+MA | 10 articles included. 3 provided sufficient data for meta-analysis. | Applying Laser according to WALT guidelines on tender points or trigger points was able to reduce pain, increase grip force, ROM and weight test. | Laser may be effective in reducing pain and improving functional outcomes if used according to WALT guidelines. |
| Tumilty S, Munn J, McDonough S, Hurley D A, Basford J R, Baxter G D. Low level laser treatment of tendinopathy: a systematic review with meta-analysis. *Photomedicine and Laser Surgery.* 2010; 28(1): 3-16. doi:10.1089/pho.2008.2470 | SR | 13 studies investigated effectiveness of LLLT in LE. 6 showed positive results. | Positive studies included 904nm, power densities between 2-100 mW/cm2 (i.e., within WALT guidelines).<br>Studies demonstrating no affect all used doses outside WALT guidelines. | Laser may be effective in reducing pain and improving functional outcomes if used according to WALT guidelines. |

**C/HPT** – Cold/Hot Pain Threshold; **CSI** – Corticosteroid injection; **DASH** – Disabilities of Arm, Shoulder and Hand Outcome Measure; **DTFM** – Deep Transverse Friction Massage; **LET** – Lateral Epicondyle Tendinopathy **; LLLT** – Low Level Laser Therapy; **MFP** – Myofacial Pressure; **MWM** – Mobilization with Movement; **NPRS** – Numeric Pain Rating Scale; **NSAID** – Nonsteroidal Anti-inflammatory Drug; **OS** – Observational Study; **PFGS** – Pain-free Grip Strength; **PPT** – Pain Pressure Threshold; **PRFEQ** - Patient-rated Forearm Evaluation Questionnaire; **PRTEE** – Patient-rated Tennis Elbow Evaluation **RCT** – Randomized Controlled Trial; **SR** – Systematic Review; **SWT** – Shock Wave Therapy; **T/V** – Transverse; **UEFS** – Upper Extremity Functional Scale; **ULNT** - Upper Limb Neural Tension; **US** – Ultrasound; **VAS** – Visual Analogue Scale; **WALT** – World Association of Laser Therapy.

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| Bjordal J M, Lopes-Martins R A B, Joense J, Couppe C, Ljunggren A E, Stergioulas A, Johnson M I. A systematic review with procedural assessments and meta-analysis of Low Level Laser Therapy in lateral elbow tendinopathy (tennis elbow). *BMC Musculoskeletal Disorders.* 2008; 9(75). doi: 10.1186/1471-2474-9-75. | SR+MA | 18 RCTs identified, with 13 meeting criteria for meta-analysis. | In a subgroup of 5 trials with 904 nm lasers and one trial with 632 nm wavelength where the lateral elbow tendon insertions were directly irradiated, weighted mean difference (WMD) for pain relief was 17.2 mm [95% CI: 8.5 to 25.9] and 14.0 mm [95% CI: 7.4 to 20.6] respectively, while RR for global pain improvement was only reported for 904 nm at 1.53 [95% CI: 1.28 to 1.83]. LLLT doses in this subgroup ranged between 0.5 and 7.2 Joules. Secondary outcome measures of pain-free grip strength, pain pressure threshold, sick leave and follow-up data from 3 to 8 weeks after the end of treatment, showed consistently significant results in favour of the same LLLT subgroup ($p < 0.02$). | LLLT administered with optimal doses of 904 nm and possibly 632 nm wavelengths directly to the lateral elbow tendon insertions, seem to offer short-term pain relief and less disability in LE, both alone and in conjunction with an exercise regimen. |
| Bisset L, Paungmali A, Vicenzino B, Beller E. A systematic review and meta-analysis of clinical trials on physical interventions for lateral epicondylalgia. *British Journal of Sports Medicine.* 2005; 39(7): 411-22. | SR + MA | 5 studies report on Laser. | Pooling of data for laser treatment was possible and showed a null summated treatment effect on pain VAS, pain-free grip strength, and global improvement at three months follow up. On long-term follow up of six months and one year there was no evidence of an effect seen with pooled data in laser over placebo, although global improvement was approaching significance. | Bjordal has published a comment on 2006 Evidence in Practice review (by Maher) that includes most of the studies in this current review, with an explanation for apparent ineffectiveness – dose too high, recent steroid injections, etc.<br>See: Bjordal J M. (2007). On "Is low-level laser therapy effective..." Maher S. *Physical Therapy.* 2006; 86: 1161-1167 [1]. *Physical Therapy*, 87(2), 224-225. |
| Trudel D, Duley J, Zastrow I, Kerr EW, Davidson R, MacDermid JC. Rehabilitation for Patients with Lateral Epicondylitis. *Journal of Hand Therapy.* 2004; 17: 243-266. doi:10.1197/j.jht.2004.02.011 | SR | 6 level 1A and 2B studies examined a total of 294 subjects and collectively investigated the effects of laser therapy versus placebo laser therapy in the treatment of LE. | The findings of all 6 studies suggest that laser is not significantly better than placebo laser for any of these outcomes in the treatment of lateral epicondylitis | |

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| Skorupska E, Lisinski P, Samborski W. The effectiveness of the conservative versus myofascial pain physiotherapy in tennis elbow patients: Double-blind randomized trial of 80 patients. *Journal of Musculoskeletal Pain.* 2012; 20(1): 41-50. doi: 10.3109/10582452.2011.635846 | RCT | ***4 groups:***<br>1. Laser.<br>2. Laser-MFP (trigger points).<br>3. US.<br>4. US-MFP (trigger points). Laser at 5 J/cm$^2$ and 1 J/cm$^2$. | Improvements in all outcome measures (VAS, DASH, grip strength) observed. Authors favour US-MFP approach. | 820 nm Laser at 5 J/cm2 to trigger points may be beneficial. |
| Emanet S K, Altan L I, Yurtkuran M. Investigation of the effect of GaAs laser therapy on lateral epicondylitis. *Photomedicine and Laser Surgery.* 2010; 28(3): 397-403. doi:10.1089/pho.2009.2555 | RCT | ***2 groups:***<br>1. Laser.<br>2. Placebo laser.<br><br>Both groups received exercise and activity modulation. | 905 nm x 12 J per Rx.<br>Significant improvement in outcomes (VAS with wrist extension, DASH, PRTEE, NHP) in both groups at 12 wks. Laser sustained benefits in long term. Note: no difference between Laser and placebo immediately post treatment (after week 3). | Laser may be beneficial in the longer term – consider in combination with exercise and modulation of pain-inducing activity. |
| Stasinopoulos D, Stasinopoulos I, Pantelis M, Stasinopoulou K. Comparing the effects of exercise program and low-level laser therapy with exercise program and polarized polychromatic non-coherent light (bioptron light) on the treatment of lateral elbow tendinopathy. *Photomedicine and Laser Surgery.* 2009; 27(3): 513-520. doi: 10.1089/pho.2008.2281 | RCT | ***2 groups:***<br>1. Exercise + LLLT.<br>2. Exercise + polarized polychromatic non-coherent light. | Both groups showed significant reduction in pain, increase in grip strength and function at week 4 and week 16. | Laser at 904 nm, 50 Hz, 0.5 J/point, 3.5 J total to 6 points may be beneficial.<br>*Note: this dose is below the current WALT guidelines.* |

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| Oken O, Kahraman Y, Ayhan F, Canpolat S, Yorgancioglu Z R, Oken O F. The Short-term Efficacy of Laser, Brace, and Ultrasound Treatment in Lateral Epicondylitis: A Prospective, Randomized, Controlled Trial. *Journal of Hand Therapy.* 2008; 21(1): 63-68. doi:10.1197/j.jht.2007.09.003 | RCT | ***3 groups:***<br>1. Brace + exercise.<br>2. Ultrasound + exercise.<br>3. Laser + exercise.<br>Patients in the LLLT group (n=20) received treatment with low-level laser for 10 minutes x five days/week for two weeks, plus a hot pack, for ten sessions. He-Ne laser - wavelength 632.8 nm; output 10 mV *[sic.]*. Laser was applied to the entire lateral epicondyle using a scanner technique.<br>No +/- laser comparison groups.<br>All groups received strengthening and stretching exercises. | Pain improved significantly in all groups.<br>Grip strength improved in Laser and US groups.<br>Global assessment – worsened in brace group, unchanged in US group, improved in Laser group. | 632.8nm delivering 6J per treatment (consistent with WALT guidelines) may be beneficial for pain, grip strength, global improvement (ns).<br>*Note: the mV in the original text is probably a typographical error – should be mW.* |
| Lam L K Y, Cheing G L. Effects of 904-nm low-level laser therapy in the management of lateral epicondylitis: a randomized controlled trial. *Photomedicine and Laser Surgery.* 2007; 25(2): 65-71. doi:10.1089/pho.2006.2047 | RCT | ***2 groups:***<br>1. Active laser (904 nm, 0.275 J/point).<br>2. Sham laser.<br>Both groups received exercise. | Significantly greater improvements were shown in all outcome measures (mechanical pain threshold, grip strength, DASH) with the Laser group than with the placebo group ($p < 0.0125$), except in the two subsections of DASH. | Laser at 904 nm, 0.275 J/point may be beneficial, when used in combination with exercise.<br>*Note: this dose is below the current WALT guidelines.* |
| Stergioulas A. Effects of low-level laser and plyometric exercises in the treatment of lateral epicondylitis. *Photomedicine and Laser Surgery.* 2007; 25(3): 205-213. doi:10.1089/pho.2007.2041 | RCT | ***2 groups:***<br>1. Active laser.<br>2. Sham laser.<br>Both groups received plyometric exercise. 904 nm, 2.4 J/cm$^2$. | Laser + exercise – significant decrease in pain at rest & on palpation, increase wrist ROM, grip strength, weight-test. | Laser at 904nm, using WALT dosage guidelines may decrease pain and improve function. |

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| Basford J R, Sheffield C G, Cieslak K R. Laser therapy: a randomized, controlled trial of the effects of low intensity Nd:YAG laser irradiation on lateral epicondylitis. *Archives of Physical Medicine & Rehabilitation.* 2000; 81(11): 1504-1510. doi:10.1053/apmr.2000.17812 | RCT | ***2 groups:***<br>1. Active laser. 1060 nm, 12.24 J/cm$^2$.<br>2. Sham laser. | No significant difference in outcomes between groups. | The dose used in this study is now considered too high – causing inhibition of fibroblast activity and impaired collagen production in injured superficial tendons.<br>*See:* Bjordal JM. (2007). On "Is low-level laser therapy effective..." Maher S. *Physical Therapy.* 2006; 86: 1161-1167 [1]. *Physical Therapy*, 87(2), 224–225. |

## ULTRASOUND (US)

| Study | Type of Evidence | Methods | Results | Implications for Practice |
|---|---|---|---|---|
| Gunduz R, Malas F U, Borman P, Kocaoglu S, Ozcakar L. Physical therapy, corticosteroid injection, and extracorporeal shock wave treatment in lateral epicondylitis. Clinical and ultrasonographical comparison. *Clinical Rheumatology.* 2012; 31(5): 807-812. doi:10.1007/s10067-012-1939-y | RCT | ***3 groups:***<br>1. US (1 W/cm2, 5 mins), hotpack, friction massage x 10 sessions.<br>2. Corticosteroid injection x 1.<br>3. ESWT x 10 sessions. | Improvements in VAS all groups @ 1, 3, and 6 months.<br>Increased grip strength @ 1 and 6 months in US group. | US at 1 W/cm2 x 5 mins may be beneficial for pain, grip strength. |
| Skorupska E, Lisinski P, Samborski W. The effective-ness of the conservative versus myofascial pain physiotherapy in tennis elbow patients: Double-blind randomized trial of 80 patients. *Journal of Musculoskeletal Pain.* 2012; 20(1): 41-50. doi: 10.3109/10582452.2011.635846 | RCT | ***4 groups:***<br>1. Laser.<br>2. Laser-MFP (trigger points).<br>3. US.<br>4. US-MFP (trigger points). | Improvements in all outcome measures (VAS, DASH, grip strength) observed.<br>Authors favour US-MFP approach. | US at 0.5 W/cm2 @ 3 MHz or 0.7 W/cm2 @ 1MHz (other details unavailable) may be beneficial. |

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| Akin C, Oken O, Fusun Koseoglu B. Short-term effectiveness of ultrasound treatment in patients with lateral epicondylitis: Randomized, single-blind, placebo-controlled, prospective study. [Turkish]<br><br>Lateral epikondilitli hastalarda ultrason tedavisinin ki{dotless}sa donem etkinligi: Randomize, tek kor plasebo kontrollu, prospektif callsma. *Turkish Journal of Rheumatology.* 2010; 25(2): 50-55.<br>doi:10.5152/tjr.2010.01 | RCT | ***2 groups:***<br>1. US (1 MHz, 1.5 W/cm$^2$, 5 mins).<br>2. Placebo. | Significantly decreased pain with motion; improvement in DASH scores; better patient satisfaction in US group. | Continuous US for 5 mins (1 MHz, 1.5 W/cm2) may be beneficial in management of pain and decreased function. |
| Oken O, Kahraman Y, Ayhan F, Canpolat S, Yorgancioglu Z R, Oken O F. The Short-term Efficacy of Laser, Brace, and Ultrasound Treatment in Lateral Epicondylitis: A Prospective, Randomized, Controlled Trial. *Journal of Hand Therapy.* 2008; 21(1): 63-68.<br>doi:10.1197/j.jht.2007.09.003 | RCT | ***3 groups:***<br>1. Brace + exercise.<br>2. US + exercise.<br>3. Laser + exercise.<br><br>All given progressive stretching and strengthening | VAS improved significantly in all groups; grip strength improved only in the laser group. | US at 1.5 W/cm2, continuous, 1 MHz x 5 mins may be beneficial. |
| Struijs P A, Damen P J, Bakker E W, Blankevoort L, Assendelft W J, van Dijk C N. Manipulation of the wrist for management of lateral epicondylitis: a randomized pilot study. *Physical Therapy.* 2003; 83(7): 608-616. | RCT | ***2 groups:***<br>1. Manipulation of the wrist.<br>2. US, friction massage and muscle stretching and strengthening. | Manipulation of the wrist appeared to be more effective than ultrasound, friction massage, and muscle stretching and strengthening exercises for the management of lateral epicondylitis when there was a short-term follow-up. | Wrist manipulation was more effective than US at 2 W/cm2, 1:4, MHz x 7.5 mins. in reducing pain at 6 weeks. There was no observed difference between interventions in terms of improved ROM, grip strength or global improvement. |

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| Kochar M, Dogra A. Effectiveness of a specific physiotherapy regimen on patients with tennis elbow: Clinical study. *Physiotherapy.* 2002; 88(6): 333-341. | RCT | ***3 groups:***<br>1. Mulligan mobilization, US and graduated exercises.<br>2. US and graduated exercises.<br>3. Control. | US group showed greater improvement than the control group on most parameters, but less improvement than found in the MM group. | US at 1.5 W/cm2, 1:5, 3 MHz x 5 mins may be beneficial. |
| 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. *Physiotherapy Canada.* 1989; (41): 93-9. | RCT | ***4 groups:***<br>1. US + placebo ointment – friction.<br>2. US + placebo ointment + friction.<br>3. Phonophoresis – friction.<br>4. Phonophoresis + friction.<br><br>*Note:* US dose varied according to patient: 1.3 W/cm$^2$ continuous to 0.5 W/cm$^2$ pulsed 1:4 x 6 minutes. Freq. not stated. | US was as effective as phonophoresis for VAS and pain-free grip strength. Authors recommend US as more cost-effective. | |
| Lundeberg T, Abrahamsson P, Haker E. A comparative study of continuous ultrasound, placebo ultrasound and rest in epicondylalgia. *Scandinavian Journal of Rehabilitation Medicine.* 1988. | RCT | ***3 groups:***<br>1. US (1 W/cm$^2$, continuous, 1 MHz x 10 mins).<br>2. Placebo.<br>3. Rest. | A significant improvement in VAS, pain on wrist DF, pain on weight lift, grip strength was noted when the effect of continuous US was compared with rest, but continuous US treatment was not significantly better than placebo US. | US at 1 W/cm2, continuous, 1 MHz x 10 mins may be beneficial. |
| Binder A, Hodge G, Greenwood A M, Hazleman B L, Thomas D P Page. Is therapeutic ultrasound effective in treating soft tissue lesions? *British Medical Journal.* 1985. | RCT | ***2 groups:***<br>1. US (1-2 W/cm2, 1:4, 1 MHz x 5-10 mins).<br>2. Placebo. | US group had significantly more participants with satisfactory outcomes on objective testing than placebo group. | US at 1-2 W/cm2, 1:4, 1 MHz x 5-10 mins may be beneficial. |
| Ruane H, Hay L, Callaghan M. Best Evidence Topic report. BET 2. Is electrotherapy useful for tennis elbow? *Emergency Medicine Journal.* 2010; 27(2): 142-144. | Short-cut Review | Seven articles<br>(1 x Cochrane Review, 3 x SR, 3 x RCT). | Weak evidence for the effects of ultrasound. | Weak evidence for the effects of ultrasound. |

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| Nimgade A, Sullivan M, Goldman R. Physiotherapy, steroid injections, or rest for lateral epicondylosis? What the evidence suggests. *Pain Practice.* 2005; 5(3): 203-215. | SR | 18 RCTs involving physiotherapy, steroid injections or rest (8 studies involved US). | Overall, there is little evidence regarding beneficial effects of isolated ultrasound, with support coming from only one study. | US may be beneficial in combination with other treatment. |
| Bisset L, Paungmali A, Vicenzino B, Beller E. A systematic review and meta-analysis of clinical trials on physical interventions for lateral epicondylalgia. *British Journal of Sports Medicine.* 2005; 39(7): 411-22. doi: 10.1136/bjsm.2004.016170 | SR | 5 RCTs included. | Based on the best evidence synthesis, there is insufficient evidence to either support or refute the use of US as a unimodal treatment for LE when based on pooled data and studies that compared it with other active treatments or a placebo. | US may be beneficial in combination with other treatment. |
| Boisaubert B, Brousse C, Zaoui A, Montigny J P. Nonsurgical treatment of tennis elbow. [French]<br>Les traitements non chirurgicaux de la tendinopathie des epicondyliens. *Annales De Readaptation Et De Medecine Physique.* 2004; 47(6): 346-355. doi:10.1016/j.annrmp.2004.05.002 | SR | 5 RCTs. | For the long term, physiotherapy (pulsed ultrasound, deep friction massage and exercise program) was the best option, but was not significantly different from the "wait-and-see" approach. | US may be beneficial in combination with other treatment. |
| Trudel D, Duley J, Zastrow I, Kerr E W, Davidson R, MacDermid J C. Rehabilitation for patients with lateral epicondylitis: a systematic review. *Journal of Hand Therapy.* 2004; 17(2): 243-266. doi:10.1197/j.jht.2004.02.011 | SR | 6 RCTs. | 4 studies found that using ultrasound alone and ultrasound in combination with other treatments could decrease pain from lateral epicondylitis. | US may be beneficial in decreasing pain – alone and in combination with other treatment. |

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| Smidt N, Assendelft W J J, Arola H, Malmivaara A, Greens S, Buchbinder R, et al. Effectiveness of physio-therapy for lateral epicondylitis: a systematic review. *Annals of Medicine.* 2003; 35(1): 51-62. | SR | 23 RCTs included in review, 5 included use of ultrasound. | 2 studies reported beneficial effects of ultrasound at 4, 8 and 13 weeks. Pooling of intermediate-term outcomes resulted in a large effect size for pain in favour of ultrasound. | Based on the best evidence synthesis, there is weak evidence for the effectiveness of US in comparison with placebo. |

## EXTRACORPOREAL SHOCK WAVE THERAPY (focused and radial)

| Study | Type of Evidence | Methods | Results | Implications for Practice |
|---|---|---|---|---|
| Haake M, Konig I, Decker T, et al. Extra-corporeal shock wave therapy in the treatment of lateral epicondylitis: a randomized multicenter trial. *Journal of Bone and Joint Surgery (Am).* 2002; 84-A(11): 1982-91. | RCT | Large multi-centered trial. n=272. All subjects had previously received unsuccessful treatment for lateral elbow pain. Local anesthetic was used for treatment comfort.<br>***2 groups:***<br>1. SWT. 2000 pulses. 0.07-0.09 mJ/mm² (low energy dose).<br>2. Sham.<br><br>3 sessions, monthly intervals. | Outcomes recorded at 6, 12 and 52 weeks. Treatment effect measured by Roles and Maudsley Score. Authors concluded that there was no benefit of SWT compared to placebo. | Although this study does not support the use of low energy SWT for LET, other studies have suggested that the use of anesthetic in SWT may reduce the effectiveness of treatment. Also, this study permitted subjects to take NSAIDs to manage post-treatment discomfort, which may reduce the tissue repair stimulus created by SWT. The interval between sessions was monthly, compared to weekly in most other studies. |
| Speed N, Nichols D, Richards C, et al. Extra-corporeal shock wave therapy for lateral epicondylitis: a double-blind randomized controlled trial. *Journal of Orthopedic Research.* 2002; 20: 895-8. | RCT | n=75. Subjects had symptoms for >3 months. No description of previous treatment was given. There was no local anesthetic provided.<br>***2 groups:***<br>1. SWT. 1500 shocks. 0.18 mJ/mm² (high energy dose).<br>2. Sham.<br><br>3 sessions, monthly intervals. | Follow-up at 4, 8 and 12 weeks using VAS score compared to a pain baseline score. A significant placebo effect was measured, as well as no additional benefit from high energy SWT. | The interval between sessions was monthly, compared to weekly in other studies. No previous treatment was described, so it is unknown whether subjects in this study had failed to respond to other treatment. The follow-up in other studies that have shown support for SWT have been >3 months. This study does not support using high energy SWT to treat LET. |

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| Crowther M, Bannister G, Huma H, Rooker G. A prospective, randomized study to compare extra-corporeal shock wave therapy and injection of steroid for the treatment of tennis elbow. *Journal of Bone and Joint Surgery (Br).* 2002; 84-B: 678-79. | Comparative Study | Prospective RCT to compare steroid injection with SWT for patients with tennis elbow. Subjects reported symptoms for >4 months. n= 73.<br>***2 groups:***<br>1. Injection (triamcinolone 20 mg).<br>2. SWT. 2000 shocks. 0.1 mJ/mm² (low energy dose).<br>3 sessions, weekly intervals. | Pain outcome measured as 50% pain reduction on VAS. Follow-up at 6 weeks and 3 months. Improvement for 84% in injection group compared to 60% in SWT group. Both treatment groups had improvement of pain scores, with injection group superior to SWT. | This study adds to the support from other studies that have found benefit from corticosteroid injection to improve pain scores in the short term for LET; however, other studies have shown no benefit in the long term. This study considers SWT impractical when comparing the lower costs of injection, but supports low energy SWT as an effective treatment for LET. |
| Chung B, Wiley JP. Effectiveness of extra-corporeal shock wave therapy in the treatment of previously untreated lateral epicondylitis: a randomized controlled trial. *American Journal of Sports Medicine.* 2004; 32(7): 1660-7. | RCT | Double-blinded RCT. n=60. Subjects with 3 weeks to 1 year history of lateral elbow pain. All subjects were previously untreated for their elbow pain. Both groups followed a forearm stretching program.<br>***2 groups:***<br>1. SWT. 2000 shocks. 0.17 mJ/mm² (high energy dose).<br>2. Sham.<br>3 sessions, weekly intervals. | Follow-up at 8 weeks.<br>Group 1 = 39% improvement<br>Group 2 = 31% improvement<br>Authors conclude that SWT (high energy) was no better than sham. | Other studies recommend that SWT should be reserved for subjects that have failed to respond to other conservative treatment, including a managed exercise program, and not introduced as a first line treatment option. In addition, the outcomes for SWT should be measured >3 months after completing treatment to allow for completion of tissue repair models. High energy SWT is not supported for treatment of LET in this study of previously untreated lateral elbow pain. |
| Rompe J, Decking J. Schoeliner S, Thies C. Repetitive low-energy shock wave therapy for treatment of chronic lateral epicondylitis in tennis layers. *American Journal of Sports Medicine.* 2004; 32(3): 734-43. | RCT | Cohort of tennis players with LET > 12 months duration. n=78.<br>***2 groups:***<br>1. SWT. 2000 shocks. 0.09 mJ/mm² (low energy dose).<br>2. Sham.<br>3 sessions, weekly intervals. | 3- and 12-month follow-up. Significant improvement in the treatment group compared to the control group was measured by pain on resisted wrist extension (VAS); Roles and Maudsley Score; UEFS (8-item questionnaire); and grip strength. | Subjects selected for low energy SWT that have failed previous conservative treatment and are re-evaluated at 3 to 12 months after treatment demonstrate measureable improvement in pain and function. This study had a sample group restricted to an athlete population. |

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| Pettrone F, McCall B. Extra-corporeal shock wave therapy without local anesthetic for chronic lateral epicondylitis. *Journal of Bone and Joint Surgery (Am).* 2005; 87A(6): 1297-1304. | RCT | Multi-center, randomized double-blinded, placebo-controlled trial. n=114. All subjects had failed to respond to previous conservative therapy.<br>***2 groups:***<br>1. SWT. 2000 shocks. 0.06 mJ/mm² (low energy dose).<br>2. Sham.<br><br>3 sessions, weekly intervals. | Outcomes for pain measured as a 50% improvement on VAS; function measured on UEFS (8-item). The SWT group (61%) demonstrated improved pain scores compared to placebo group (29%), and a significant improvement in function scores.<br>These improvements were maintained at 6 months and 1 year on follow-up. | This study supports the use of low energy SWT for pain and function to treat LET when subjects have failed to respond to other conservative therapy. The study has a similar design and outcome as Rompe et al. (2004) to support low energy SWT for treating LET in both athletes and the general population. |
| Spacca G, Necozine S, Cacchio A. Radial shock wave therapy for lateral epicondylitis: a prospective randomized controlled single-blind study. *European Journal of Physical and Rehabilitation Medicine.* 2005; 42(1): 17-25. | Single-blind RCT | Prospective single-blinded study design. Use of radial SWT, which produces shock energy by a pneumatic mechanism. All subjects had failed to respond to previous conservative treatment. n=65.<br>***2 groups:***<br>1. SWT. 2000 shocks. 1.2 Bars (low energy dose).<br>2. Sham.<br><br>4 sessions, weekly intervals. | At 6-week and 6-month follow-up, SWT group demonstrated significant improvement in pain (VAS); pain-free grip strength; and function (DASH). Also, high patient satisfaction at 6 months (84%). | The authors provide evidence that the mode of generating low energy shock waves using a pneumatic generating SWT device can provide similar outcomes to SWT generated by electromagnetic or piezo-electric devices. This study has a small sample size and lacks a true control group. |
| Stasinopoulos D, Johnson M. Effectiveness of extra-corporeal shock wave therapy for tennis elbow (lateral epicondylitis). *British Journal of Sports Medicine.* 2005; 39(3): 132-6. | SR | Computerized searches of databases (1988-2004) were performed by reviewing abstracts of articles to find inclusion criteria. 7 studies were selected for review of full texts. All studies were RCTs in English only. | This was the first review on SWT for LET to include only quality RCTs in the inclusion. There are conflicting results that prevent drawing a final conclusion about the effectiveness of SWT for LET. | Further research with well-designed RCTs is required. Studies reviewed had different designs and conclusions. |

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| Buchbinder R, Green S, Youd J, et al. Systematic review of the efficiency and safety of shock wave therapy for lateral elbow pain. *Journal of Rheumatology.* 2006; 33(7): 1351-63. | SR | Using the Cochrane Review methodology, 9 placebo-controlled RCTs and 1 comparative study were selected. Data was pooled for meta-analysis. | This review found no evidence to support SWT compared to placebo for LET after comparing studies and pooling data for analysis | The studies reviewed were of different design, using different selection criteria of subjects, some using local anesthetic, different follow-up points, and different energy dosages. Other authors conclude that when data and study designs are too clinically heterogeneous, a meta-analysis should be avoided, such a pooling data to make conclusions about a treatment effectiveness, and a qualitative analysis be performed instead. |
| Rompe J, Muffulli N. Repetitive shock wave therapy for lateral elbow tendinopathy (tennis elbow): a systematic and qualitative analysis. *British Medical Bulletin.* 2007; 83(1): 355-78. | SR | These authors state that studies which incorporate heterogeneous designs should not have their data pooled in a meta-analysis. Instead, these authors performed a qualitative review of each of the 10 clinical trials which had been previously reviewed in the systematic review by Buchbinder et al. (2006). | There are conflicting findings (dependent upon the method used to undertake the review) from systematic reviews of the literature on SWT for LET.<br><br>In this review, 2 well-designed RCTs provided good support for low energy SWT.<br><br>3 other high-quality trials did not show benefit with SWT over placebo. Studies that did not support SWT used inconsistent study designs, such as enrolling acute subjects, applying local anesthetic, or using short follow-up periods. | Evidence for SWT is found when trials of similar design are compared.<br>• Subjects are selected because they have failed to respond to other therapy<br>• Low energy SWT is applied at energy flux density <0.1 mJ/mm².<br>• Clinical focusing is applied, where the treatment is aimed at the area of maximum tenderness as reported by the patient, and not dependent upon ultra-sound guidance to localize the treatment<br>• No anesthetic is used, which is generally tolerated by patients at the lower energy levels<br>• Follow-up is at least >3 months after the completion of the treatment<br>• Three treatments are applied at weekly intervals<br>• Patients are instructed to avoid NSAIDS for the follow-up period |

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| Staples M, Forbes A, Ptasznik R, Gordon J, Buchbinder R.<br><br>A randomized controlled trial of extracorporeal shock wave therapy for lateral epicondylitis (tennis elbow). *Journal of Rheumatology 2008.* 31(10): 2038-46. | RCT | Double-blinded, randomized, placebo-controlled trail. No previous treatment was involved in the selection process, but symptoms were present for at least 6 weeks. Patients performed stretching exercise and wore splints/braces if desired. NSAIDS were also allowed after the initial 6 week follow-up. n=68.<br><br>***2 groups:***<br>1. SWT. 2000 shocks. 0.56 mJ/mm² (very high energy dose).<br>2. Sham.<br><br>3 sessions, weekly intervals. | Follow-up at 6 weeks, 12 weeks and 24 weeks using VAS, pain-free grip score, and several functional questionnaires (DASH, SF-35, PET global health score). No significant differences in any outcomes between treatment group and placebo at any of the follow-up points. | This study applied a very high dose of SWT energy. No anesthetic was used considering such a high energy dose of focused SWT. Clients were not controlled on the other types of treatment they sought after the initial 6 week beyond completing the therapy. This design of this study is not as robust compared to other studies using low energy SWT, and has a small treatment group. Although the study was conducted between 1998-2001 it was not published until 2008. |
| Ozturan K, Yucell I, Cakici H, Guven M, Sungur I. Autologous blood and corticosteroid injection and extracorporeal shock wave therapy in the treatment of lateral epicondylitis. *Orthopedics.* 2010; 33: 84-91. | Comparative Study | Corticosteroid injections, autologous blood injections, and SWT (+ local anesthetic) were compared for short and long term outcomes. No previous treatment was reported, but subjects has symptoms >6 months. n=60.<br><br>***3 groups:***<br>1. Corticosteroid (methylprednisone 1ml).<br>2. Autologous blood (2 ml).<br>3. SWT (local anesthetic). 2000 shock. 0.17mJ/mm² (high energy dose).<br><br>3 sessions, weekly intervals. | Outcomes using VAS, UEFS (8-item), and maximal grip strength were recorded at 4, 12, 26 and 52 weeks. Corticosteroid injection was most successful in the short term. However, autologous blood injection and SWT scored better results in the long term. At 1 year, success rate for autologous blood injection (83%) and SWT (89%) exceeded corticosteroid injection (50%). Autologous blood injections have less equipment costs than SWT. | The initial success of corticosteroid injection on short-term pain control is also supported by other studies, but with high recurrence rates. Better long-term results with both autologous blood injection and SWT offer treatment consistent with addressing degenerative tissue in tendinopathies, such as LET. This study lacks the rigors of controls in the design, and used local anesthetic with SWT. |

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| IONTOPHORESIS WITH DEXAMETHASONE | | | | |
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| **Study** | **Type of Evidence** | **Methods** | **Results** | **Implications for Practice** |
| Runeson L, Haker E. Iontophoresis with cortisone for the treatment of lateral epicondylagia (tennis elbow). *Scandinavian Journal of Medicine and Science in Sports.* 2002; 12: 136-42. | RCT | Subjects with lateral elbow pain >1 month; median pain duration of 4 months (placebo group) and 6 months (treatment group). n=64.<br>***2 groups:***<br>1. 0.4% Dexamethasone Sodium Phosphate.<br>2. Placebo (saline).<br><br>Both groups received delivery at 40mA-min, 4 sessions on alternate days. | Pain measured by VAS after finishing treatment (1-day, 3-month, 6-month follow-up) using resistance and palpation tests, and grip pain. Both groups improved, but no difference measured between iontophoresis group and placebo. | This study does not support Dexamethsone iontophoresis in the treatment of LET. Subjects in this study were not limited to symptoms in the acute phase, which may weaken the effectiveness of Dexamethasone iontophoresis as a treatment choice. |
| Nirschl R, Rodin D, Ochiai D, Martmann-Moe C. Iontophoretic administration of Dexamethasone for acute epicondlyitits: a randomized double-blinded placebo controlled study. *American Journal of Sports Medicine.* 2003; 31: 915-20. | RCT | Large sample size n=199. Subjects selected with early onset of lateral elbow pain (<3 months).<br>***2 groups:***<br>1. 0.4% Dexamethasone Sodium Phosphate<br>2. Placebo (saline).<br><br>Delivery dose = 40 mA-min, 6 sessions within 2 weeks at 1-3 day intervals. | Pain measured by VAS for palpation tenderness and functional activity at 2 days and 1 month follow-up.<br>Significant improvement measured at 2 days after finishing treatment, but no difference between groups at 1 month. | This study suggests short-term benefit using Dexamethsone iontophoresis for early pain reduction so that subjects can continue with active rehab and work. It also highlights some of the advantages of using iontophoresis to deliver corticosteroid over injection. It supports other studies that have found no long-term benefit of corticosteroids in treating lateral elbow tendinopathy. |

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| Sefanou A, Marshall N, Holdon W, Siddiqui A. A randomized study comparing corticosteroid injection to corticosteroid iontophoresis for lateral epicondylitis. *Journal of Hand Surgery.* 2012; 37(1): 104-9. | Comparative Study | Subjects with chronic lateral elbow tendinopathy were selected, with symptoms 10-15 months. n=101.<br>All groups participated in a standard 8-week therapy program that progressed in stages from rest-mobility-strength.<br>***3 groups:***<br>1. Iontophoresis. Dexamethasone - 10mg. 1-volt 'iontopatch-80' = 80mA-min. 3 sessions, 24-hr intervals, alternate days.<br>2. Injection. Dexamethasone - 10 mg (shorter-lasting glucocorticoid steroid).<br>3. Injection. Triamcinolone - 10mg (longer-lasting glucocorticoid steroid). | Grip strength, PRTEE questionnaire and work status were measured at completion of treatment and at 6 months. The iontophoresis group had better outcomes at 6 weeks, but all groups showed similar improvement at 6 months. | Introduction of corticosteroid with iontophoresis has similar outcomes to steroid injection with advantages of reducing side effects of injection. The mechanism behind treating tendinopathy with steroids may be helpful in the short term for pain reduction, but does not improve the degenerative process in the tendon. Although this study used steroids in subjects with long-term tendon pain, introduction of corticosteroid by iontophoresis or injection may be better suited in the early acute stage of lateral elbow pain. |
| **IONTOPHORESIS WITH NSAID** | | | | |
| Demirtas R, Oner C. Treatment of lateral epicondylitis by ionotophoresis of sodium salicylate and sodium diclofenac. *Clinical Rehabilitation.* 1998; 12: 23-29. | Comparative study | n=40. Subjects with LET symptoms of mean duration 5.2 months. In addition to iontophoresis, subjects also received 20 minutes of infra-red heat lamp after each treatment.<br>***2 groups:***<br>1. Diclofenac (Voltaren)<br>2. 2% Sodium Salicylate.<br>Delivered by iontophoresis. 6-11 mA x 20 minutes (> 120mA-min). Daily, up to 18 days. Treatment was discontinued if pain scores dropped to '0' during treatment period. | Pain scores 0-3, (0=no pain; 3=severe pain) were recorded for local elbow pain on pressure and pain upon resisted wrist extensor testing. On completion of the study (< 3weeks), significantly improved pain scores were measured for both groups, with Diclofenac superior to Sodium Salicylate. | In the short term, iontophoresis with NSAID can improve lateral elbow pain with no side effects. This study has no control group, and does not account for any benefit from the additional use of infra-red heat. There was no follow-up, so that no long-term benefit can be concluded. A high number of treatment sessions were involved within a 3-week period. |

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| Baskurt F, Ozcan A, Algun C. Comparison of effects of phonophoresis and iontophoresis of naproxen in treatment of lateral epicondylitis. *Clinical Rehabilitation.* 2003; 17: 96-100. | Comparative study | n= 61. Duration of LET symptoms not provided. Subjects participated in a physiotherapy treatment program that included ice, stretch and progressive resistance exercise for the forearm extensors group, as well as receiving Naproxen through iontophoresis or phonophoresis at each treatment session.<br>***2 groups:***<br>1. Phonophoresis. 10% Naproxen gel, (1MHz; 1W/cm2).<br>2. Iontophoresis. 10% Naproxen gel, (0.08-0.004 mA/cm2).<br>Approximately 20 treatment sessions for each group. | Pain scores were measured before treatment and upon follow-up for local elbow pressure, and pain on grip testing. In addition, the Nirschl-Pettrone grading scale (poor-moderate-good-excellent) was recorded.<br>Both groups showed significant improvement for pain, grip strength and functional outcome at completion of the study (mean 4.5 months). | Iontophoresis and phonophoresis using Naproxen showed equal improvement for the treatment of LET, measurable at approximately 4 months after treatment. In this study, the benefits of different methods of delivering Naproxen cannot be differentiated from the concurrent physiotherapy treatment or the natural resolution of LET over time. In addition, there were a high number of treatments provided over an unspecified period of time. |
| **IONTOPHORESIS WITH LIDOCAINE** | | | | |
| Yarrobino T, Kalbfleisch J, et al. Lidocaine ion mediates analgesia in lateral epicondylalgia treatment. *Physiotherapy Research International.* 2006; 11(3): 152-160. | Experimental study | n=5. A small experimental group of subjects with lateral elbow pain of mean duration <6 months received Lidocaine iontophoresis concurrent with other physical therapy (ice, deep transverse friction massage, stretching).<br>4% Lidocaine Hydrochloride.<br>Iontopatch (80 mA-min), worn for 24 hours after each therapy session.<br>3 treatment sessions on alternate days.<br>(Total treatment duration 6 days). | Pain on local lateral elbow pressure (dolorimetry) was measured at the beginning of each session, and 1 week after completing treatment. At the end of this 2 week study, all subjects measured significant improvement in pain scores. | In the short term, iontophoresis with Lidocaine can improve lateral elbow pain. This study is experimental with a very small sample size, and no control to account for the benefits of other concurrent physiotherapy treatment. No long-term benefit can be attributed to treatment, and 1 subject returned within 3 months to receive other treatment (corticosteroid injection). |

| ORTHOTIC DEVICES | | | | |
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| **Study** | **Type of Evidence** | **Methods** | **Results** | **Implications for Practice** |
| Struijs PA, Smidt N, Arola H, Dijk CN, Buchbinder R, Assendelft WJ. Orthotic devices for the treatment of tennis elbow. *Cochrane Database of Systematic Reviews.* (1):CD001821, 2002. | SR | The following databases were searched: Medline, Embase, CINAHL, the Cochrane Controlled Trial Register, Current Contents up to May 1999, and reference lists from all retrieved articles. Experts on the subjects were approached for additional trials. | 5 RCTs were included. No definitive conclusions could be drawn concerning effectiveness of orthotic devices for lateral epicondylitis. | Early studies were assessed as inconclusive. |
| Buchbinder R, Green SE, Struijs P. Tennis elbow. *Clinical Evidence* (Online). 2011; pii: 1117. | SR | Medline, Embase, The Cochrane Library, and other important databases were searched up to November 2009 | 5 RCTs were included (3 overlapped with Struijs et al, and an additional 2 RCTs were included.) | There was weak evidence that bracing may be less effective than a multimodal physiotherapy approach at medium term (6 weeks) improvements in pain and function. |
| Dwars BJ, de Feiter P, Patka P, Haarman HJ. Functional treatment of tennis elbow. A comparative study between an elbow support and physical therapy. *Sports, Medicine and Health; Proceedings of the XXIV World Congress of Sports Medicine.* 1990; 237-41. | RCT | 120 patients with LET (unspecified duration) randomized to ***2 groups:***<br>1. Orthotic device (Epitrain).<br>2. Multimodal physical therapy. | 25/60 physical therapy patients and 11/60 orthotic patients dropped out of the study. In the remaining patients, there was no significant difference in the amount of pain at 6 weeks. | Inconclusive results. |
| Holdsworth LK, Anderson DM. Effectiveness of ultrasound used with a hydrocortisone coupling medium or epicondylitis clasp to treat lateral epicondylitis: Pilot study. Physiotherapy 1993;79: 19-25. | RCT | 42 patients randomized to ***4 groups:***<br>1. Orthotic device (epicondylar clasp) alone.<br>2. Orthotic device with cortisone phonophoresis.<br>3. Phonophoresis alone.<br>4. Ultrasound alone (3MHz, 1.5W/cm2, continuous, 5 minutes, 12 treatments). | There were no differences in assessed outcomes in any group. There was wide variation in the outcome measures. | Inconclusive results. |

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| Erturk H, Celiker R, Sivri A, Cetin A, Cindas A. The efficacy of different treatment regiments that are commonly used in tennis elbow. *Journal of Rheumatology and Medical Rehabilitation.* 1997; 8: 298-301. | RCT | 36 patients with LET (symptom range 3-156 weeks) randomized to ***4 groups:***<br>1. NSAID plus Aircast pneumatic arm band.<br>2. Local injection of corticosteroids with arm band.<br>3. Local injection of corticosteroids without arm band.<br>4. Arm band alone. | After three weeks, there was a significant reduction in resting pain in all groups except for the group receiving arm band alone. | Inconclusive results. |
| Burton AK. A comparative trial of forearm strap and topical anti-inflammatory as adjuncts to manipulative therapy in tennis elbow. *Manual Medicine.* 1988; 3(4): 141-3. | RCT | 33 patients with acute (<3 month duration) LET randomized to ***4 groups:***<br>1. Forearm strap (n=8).<br>2. Elbow osteopathic manipulation (n=8).<br>3. Topical anti-inflammatory (n=9).<br>4. Strap plus topical anti-inflammatory (n=8). | There were no differences in assessed outcomes (pain, grip strength) among groups during a 3 week recovery period. There was wide variation in the assessed outcomes. | Inconclusive results. |
| Struijs PA, Kerkhoffs GM, Assendelft WJ, Van Dijk CN. Conservative treatment of lateral epicondylitis: brace versus physical therapy or a combination of both-a randomized clinical trial. *American Journal of Sports Medicine*. Mar 2004; 32(2): 462-9. | RCT | 180 patients with >6 week symptom duration randomized to ***3 groups:***<br>1. Brace-only treatment.<br>2. Physical therapy (ultrasound, exercise, friction massage).<br>3. Combination of these.<br><br>Main outcome measures were success rate, severity of complaints, pain, disability, and satisfaction. | Physical therapy and combination therapy were superior to brace-only at 6 weeks. Combination treatment was not superior to physical therapy alone. | Physical therapy is superior to counterforce brace for pain and treatment success at 6 weeks.<br><br>Addition of counterforce brace to physical therapy produced no additional benefits. |

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| Garg R, Adamson GJ, Dawson PA, Shankwiler JA, Pink MM. A prospective randomized study comparing a forearm strap brace versus a wrist splint for the treatment of lateral epicondylitis. *Journal of Shoulder & Elbow Surgery*. Jun 2010; 19(4): 508-12. | RCT | 42 patients with acute LET (44 elbows).<br>***2 groups:***<br>1. A wrist extension splint (Group 1 -24 elbows).<br>2. Counterforce forearm strap (Group 2 -20 elbows).<br><br>Patients were instructed to wear the brace during all daytime hours for a period of 6 weeks. In addition to bracing, patients were given standardized instructions in icing and home stretching exercises. Brace removal was allowed only for bathing, sleeping, and during performance of stretching exercises. | Pain relief after 6 weeks was significantly better with the extension splint group (P = .027, measured as "pain at worst"). No other variables, including functional scores, were statistically significantly different (i.e., both groups improved to an equivalent degree). | The wrist extension splint may allow a greater degree of pain relief than does the forearm strap brace for patients with acute lateral epicondylitis. |
| Altan L, Kanat E. Conservative treatment of lateral epicondylitis: comparison of two different orthotic devices. *Clinical Rheumatology.* Aug 2008; 27(8): 1015-9. | RCT | 50 patients with acute LET (< 12 weeks symptoms).<br>***2 groups:***<br>1. Counterforce brace.<br>2. Wrist splint.<br><br>Patients were instructed to wear their braces continuously. In the event of discomfort, patients were allowed to take off their braces for no longer than an hour. | Pain relief after 2 weeks was slightly greater with the extension splint group. At 6 weeks, improvements in pain and grip strength were equivalent in the two groups. | The wrist extension splint may allow a greater degree of pain relief than does the forearm strap brace for patients with acute lateral epicondylitis. |
| Van De Streek MD, Van Der Schans CP, De Greef MH, Postema K. The effect of a forearm/hand splint compared with an elbow band as a treatment for lateral epicondylitis. *Prosthetics & Orthotics International.* Aug 2004; 28(2): 183-9. | RCT | Forty-three (43) patients with chronic (>3 weeks) LE that met the inclusion criteria randomized to ***2 groups:***<br>1. Elbow band.<br>2. Splint group.<br><br>They wore the orthotic devices for 6 weeks. Outcome measures were obtained at baseline and directly after the intervention. | No differences between the counterforce brace and splint group. Outcome measures were maximal grip strength, pain during gripping, and the Patient-Rated Forearm Evaluation Questionnaire (PRFEQ). | No clear difference between splint and counterforce brace in this trial. |

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| Faes M, van den Akker B, de Lint JA, Kooloos JG, Hopman MT. Dynamic extensor brace for lateral epicondylitis. *Archives of Physical Medicine and Rehabilitation.* Jul 1998; 79(7): 832-7. | RCT | Included both acute and chronic patients.<br>***2 groups***<br>1. Dynamic wrist splint n=30.<br>2. No splint. n=33.<br><br>Other treatments were allowed per patient preference. | 21 patients in the splint group completed the trial, compared to 30 in the no-splint group. | This trial is inconclusive due to high number of dropouts. |
| 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. *Clinical Orthopedics and Related Research.* Jan 2006; 442: 149-57. | RCT | Brace arm (n=20) group described here:<br>A counterforce brace was applied for 2 weeks, and then discontinued for 4 weeks. Progressive exercise (stretch and strengthening) were carried out for 6 weeks. Pain and grip strength were measured at 2 and 6 weeks. | Pain and grip improved significantly after 2 weeks, at which point the brace was discontinued. At 6 weeks, pain had significantly worsened (back to baseline values). | Bracing may be helpful, but patients may experience a worsening of pain if the bracing is discontinued too early. |
| Haker E, Lundeberg T. Elbow-band, splintage and steroids in lateral epicondylalgia (tennis elbow). *Pain Clinics.* 1993; 6: 103-112. | RCT | 61 patients with chronic LET (>1 month) were randomized to ***3 groups:***<br>1. Elbow band.<br>2. Splint.<br>3. Local injection of triaminolone acetonide. | At three months, 50% of patients receiving elbow band reported good or excellent results, compared to 21% in the splint group and 63% in the steroid group. However, the only statistically significant differences were in favour of steroids at the short term (2 weeks). | Splinting does not appear to be effective in patients with chronic LET. |

| TAPING | | | | |
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| **Study** | **Type of Evidence** | **Methods** | **Results** | **Implications for Practice** |
| Vicenzino B, Brooksbank J, Minto J, Offord S, Paungmali A. Initial effects of elbow taping on pain-free grip strength and pressure pain threshold. *Journal of Orthopaedic & Sports Physical Therapy.* Jul 2003; 33(7): 400-7. | Repeated-measures design in which the subjects acted as their own controls | ***2 groups:***<br>1. Application of diamond-shaped taping.<br>2. Placebo or no-tape (control). | The data from this preliminary study demonstrate positive changes in both pain-free grip strength and pressure pain threshold with taping. This effect was maintained for 30 minutes after tape application. The maximum improvement in pain-free grip strength was on average 24.2% at the<br>30-minute post-application measurement time, whereas the maximum positive change in pressure pain threshold was 19.2%. | Taping may be helpful. |
| Shamsoddini A, Hollisaz MT. Initial effect of taping technique on wrist extension and grip strength and pain of Individuals with lateral epicondylitis. *Iranian Rehabilitation Journal.* 2010; 8(11). | Repeated-measures design in which the subjects acted as their own controls | ***2 groups:***<br>1. Application of diamond-shaped taping.<br>2. Placebo or no-tape (control). | Grip strength on the affected side improved by approximately 3.9kg following taping treatment. Pain was reduced from 4.13±1.1 to 2.16±0.9. | Taping may be helpful. |

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