Principles of Sports and Orthopaedic Physiotherapy , Chronic Lateral Epicondylalgia An Annotated Bibliography and Case Management

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Introduction

Lateral epicondylalgia (LE) is also known as lateral epicondylitis, tennis elbow, or ECRB tendinosis (Abbott et al 2001). The pathophysiology of the condition is less commonly inflammation ("itis") or degeneration ("osis") and is predominantly hyperalgisia and pain ("algia") (Vicenzino and Wright in Abbott et al 2001). That's why due to deferent pathologies or combinations of pathologies that can cause it, LE can be difficult to be diagnosed.

LE is a frequently reported condition in daily clinical practice. The main complaint is characterized by pain over the lateral epicondyle of the humerus, which is aggravated with resisted wrist dorsi flexion. Resisted extension of the middle finger with the wrist in neutral can be the most provocative. Several treatment options have been suggested to treat this condition including corticosteroid injections, orthotic devices, iontoforesis, physiotherapeutic modalities such as exercises, ultrasound, shock wave therapy, laser, massage, electrotherapy but also manual therapy, acupuncture and less common surgery (Struijs et al 2004).

There are approximately 4-7 Incidence per 1000, per year of LE treated in general practice (Bisset et al 2005, Smidt et al 2002). Duration of an episode is estimated between 6 months to two years

and a small proportion undergoes surgery. LE occurs more in men than women and tends to involve the dominant side. Characteristically, symptoms of tennis elbow occur in patients more than 35 years old, whose activity level, sports or occupations require repetitive activity and who have a compromised fitness or conditioning levels. The repetitive strain on the tendons of the forearm muscles at the point at which they attach to the elbow leads to inflammation and ultimately to degenerative changes such as tendinosis, micro tears, and fibrous tissue healing at these points (Vicenzino 2003, Nirschl 1981)

The degree of injury may range from minor disruption of collagen fibers to partial tears of the ECRB tendon at its attachment to the lateral epicondyle. Other problems that may cause lateral elbow pain are radiohumeral joint pathology, and dysfunction of the cervical spine at C5-C6 or C6-C7, which can refer pain to the lateral elbow area. The radial wrist extensors are primarily of the C6 myotome, and the lateral epicondyle is considered to be the C7 sclerotome (Ekstrom and Holden 2002).

Another common cause of lateral elbow pain is radial tunnel syndrome (RTS) associated with entrapment of the deep branch of the radial nerve usually located at the tendinous margin of the ECRB muscle origin, the arcade of Frohse of the supinator muscle and the distal border of the supination muscle (Ekstrom and Holden 2002). Surgeries releasing these sites have been proved successful in the past. The exact cause of entrapment can be determined only at the time of surgery.

Purpose-Methods

Within the purposes of this paper is to investigate the most valid and high quality evidence in current relative literature, in order to determine the effectiveness of different therapeutic approaches for the treatment of this multifactorial condition, including conservative and surgical

interventions. That's why only recently (published the last five years) randomized, controlled, trials (RCTs) of good methodological quality (level 2 or 3 of hierarchy of evidence) and systematic reviews (level 1 of hierarchy of evidence) are included in this bibliography. Studies were excluded if:

were published before 1999
were bellow level 3 in the hierarchy of evidence

Initially the PEDro Physiotherapy Evidence Database was reached. This database contains only recent RCTs and systematic reviews. In most cases a scoring of the study is also indicated, making the choice of studies more easy and efficient. The simple search mode of this database was chosen. The key words used to identify the relative studies were:

Tennis Elbow
Lateral Elbow Pain
Lateral Epicondylalgia
Lateral Epicondylitis
Physical Therapy
Conservative
Physical Means
Surgery
NSAIDs
Injection

Key words were used in deferent combinations to ensure that no study would be missed because of deferent terminology between authors.

Twenty two studies were initially allocated. With the exception of one systematic review no other study investigated surgical approaches. That's why another two studies were included from the reference list of one very recent RCT. The distribution was as follow:

8 systematic reviews
10 RCTs
3 other experimental studies
2 observational studies
1 case study

The main purpose of the author was to investigate most of the variety of interventions, but the total number of included studies had to be approximately 10. That's why in case deferent systematic reviews were investigating the efficacy of the same treatment modality, only one of each was planned to be included. In respect to the quality of evidence, recent systematic reviews from the Cochraine Collaboration were prioritized. The Cochraine Collaboration is known for its strict standards and high quality reviews. When two or more RCTs were investigating the same intervention the most recent with the best methodological quality was included. It was observed that most of the initially allocated RCTs were comparing the efficiency of similar interventions. In that case some RCTs of lower methodological quality or older publication were also included in order to cover most of the variety of therapeutic approaches for the treatment of tennis elbow.

With respect to the above additional inclusion criteria ten studies were included in this paper; 5 systematic reviews, 3 RCTs, and 2 experimental studies. The reference lists of the included systematic reviews were also investigated in order to avoid including an RCT of which the data was already in the results of a systematic review. The methodological quality, results, conclusions and implications of treatment of lateral elbow pain of each study, are summarized in the tables bellow.

Methodological quality of each review paper was assessed with a modified Greenhalgh critical appraisal tool (Appendix I). The original Greenhalgh tool consists of five questions and makes scoring of review papers quick and efficient. All included reviews were finally from the Cochraine Collaboration which has contributed to the formation of this critical appraisal tool. So the use of

the original paper would favour the scoring of these papers. That's why the modified Greenhalgh tool consisted of one extra question. The quality of RCTs was assessed with the PEDro critical appraisal tool (Appendix II) modified into ten items instead of eleven, as proposed by its' designers.

Study 1

Study title: Acupuncture for lateral elbow pain (review)

Journal: The Cochraine Collaboration, 21 January 2002, issue 1

Data base: The PEDro Physiotherapy Evidence Database

Key words: Tennis Elbow, Randomized Controlled trial, Review, Acupuncture

Study type: Systematic Review **Level of evidence**: level 1

Critical appraisal tool: The Greenhalgh appraisal tool modified into 6 items **Study score:** 6/6

Summary/comments: This systematic review aimed to determine the effectiveness of acupuncture for the treatment of adults with lateral epicondylalgia. In the background section of this review it was made clear that although acupuncture is often recommended for the treatment of lateral elbow pain, few studies have investigated the efficacy of this intervention. No systematic review had been published by that time, specifically addressing the effectiveness of acupuncture for pain relief and dysfunction from lateral epicondylalgia.

The authors of this review aimed to include only RCTs published in all languages. Participants should be adults, with relevant symptoms for more than 3 weeks, no history of relevant surgery or trauma and other systemic disease. Each study should include acupuncture vs placebo, or acupuncture vs another modality. Outcomes of interest included pain at rest and movement, function, disability, quality of life, grip strength, participant's perception of overall effect or global preference, range of motion (active and passive) and adverse effects.

Electronic searches of MEDLINE, CINAHL, EMBASE and SCISEARCH were combined with searches of the Cochrane Clinical Trials Registar and the Musculoskeletal Review Group's specialist trial database from 1966 to June 2001. Searches were conducted up to October of 2001.

Two independent reviewers assessed all identified studies with respect to pre-set inclusion/exclusion criteria. Finally four RCTs were included. Of them, two trials compared needle acupuncture to placebo but used different outcomes measures. One trial compared laser acupuncture to placebo and the last one compared a combination of acupuncture and vitamin B12 injection vs vitamin B12 injection alone. All trials defined tennis elbow with the similar diagnostic criteria and excluded participants with cervical pathology. Due to the clinical heterogeneity of differing interventions and timing of outcome assessment, data from those trials could not be combined in a meta-analysis.

The first RCT found that needle acupuncture resulted in pain relief for significantly longer than placebo (Weighted Main Difference=18.8hrs, 95%CI 10.1 to 27.5) and is more likely to result in a 50% or grater reduction of pain after one session (Relative Risk= 0.33, 95%CI 0.16 to 0.69). The second RCT demonstrated that needle acupuncture is more likely to result in overall participant improvement than placebo in the sort-term (Relative Risk= 0.09, 95%CI 0.01 to 0.64). No significant differences were mentioned in the long-term assessment (3 and 12 months follow up).

The laser acupuncture trial showed no differences with placebo in the overall patient's benefit.

The last trial, published in Chinese, demonstrated no difference between vitamin B12 injection plus acupuncture and vitamin B12 injection alone.

There is insufficient evidence to either support or refute the use of acupuncture (needle or laser) in

the treatment of tennis elbow. This review demonstrated short-term benefits of acupuncture in pain, but these findings were based on two small trials the data of which weren't able to be combined in a meta-analysis. No trial commented any adverse effect. No benefit was demonstrated to last more than 24 hrs after treatment.

We can conclude that no current evidence supports long-term effects of acupuncture in lateral elbow pain. Acupuncture might be able to provide short-term symptom relief from tennis elbow, but more research is needed to support a strong opinion.

Study 2

Study title: Conservative Treatment of Lateral Epicondylitis. Brace versus Physical Therapy or a Combination of Both-A randomized controlled

trial.

Journal: The American Journal of Sports Medicine (2004), 32(2): 462-469

Data base: The PEDro the physiotherapy evidence data base

Key words: Tennis Elbow, Randomized Controlled trial, Physical therapy, Conservative, brace

Study type: Randomized, Clinical Trial **Level of evidence**: level 2

Critical appraisal tool: The PEDro appraisal tool modified into 10 items **Study score:** 9/10

Summary/comments: The purpose of this study was to evaluate the effectiveness of brace

treatment, physical therapy and the combination of both in patients suffering from tennis elbow**.** Relative background was well discussed. 180 subjects were randomized with computer software into the three intervention groups. Participants had been diagnosed with lateral epicondylitis and had complaints for at least 6 weeks. The patients were included if reported pain on the lateral side of the elbow, which was aggravated with both pressure on the lateral elbow and resisted wrist dorsi flexion. Baseline assessments were undertaken by a medical doctor blinded to the groups. The physiotherapy group during the 6 week intervention period received a total of nine sessions. The protocol consisted of 7.5 minutes ultrasound, 5-10 minutes massage and a progressive exercise program focused on the wrist that initiated since patients symptoms had subsided. The exercise program was thoroughly described, so it could be reproducible. However I would disagree that 7.5 minutes were enough to bring on the tissues' physiological responses to ultrasound. The evidence from background literature is also controversial concerning the duration and type of application of ultrasound.

The brace group was provided with a brace immediately after randomization and was advised to avoid activities that worsen their symptoms. The third group, received combination of both the physiotherapy and brace protocols. Outcomes were mainly assessed at the end of the intervention and after one year follow up. The main, outcome measures were success rate, severity of complaints, pain, disability and satisfaction. Data was analysed with intention to treat and a per-protocol analysis. No significant variations in baseline characteristics were identified. The drop out rate was only 6% on one year follow up. An additional physiotherapy treatment was given to all groups during long-term follow up. The study results answered clearly the initial question, however they were conflicting. It was concluded that physical therapy is superior to brace-only over the short-term for pain, disability and satisfaction. Combination treatment proved more effective than brace only on 6 weeks follow-up for severity of complaints, disability and satisfaction. Combination treatment had no advantage over physical therapy. At the long-term follow-up no significant differences were observed between groups.

The authors showed awareness of the limitations of their trial. They gave reasonable explanation of the main outcomes and suggested implications of their results for future trials. This study challenged

the usefulness of a physiotherapy program consisting of ultrasound, stretches and wrist exercises, when patients can manage their symptoms only by wearing a tennis elbow brace.

Study 3

Study title: Corticosteroid injections, physiotherapy, or a wait-and-see policy for lateral epicondylitis: a randomized controlled trial

Journal: The LANCET (2002), 359: 657-662

Data base: The PEDro Physiotherapy Evidence Database

Key words: Tennis Elbow, Randomized Controlled trial, Physical therapy, Conservative, Corticosteroid

Study type: Randomized, Controlled, Trial **Level of evidence**: level 2

Critical appraisal tool: The PEDro appraisal tool modified into 10 items **Study score:** 8/10

Summary/comments: In the introduction section of this study, background data suggests that the effectiveness of physiotherapy, corticosteroid injections, and non-steroidal anti-inflammatory drugs for lateral epicondylitis present conflicting results. It was also evident that corticosteroid injections are safe and effective only in the short-term in lateral epicondylalgia. In view of the absence of scientific data for the effectiveness of active interventions, and the benign course of lateral epicondylitis, the clinical guidelines of the Dutch College of General Practitioners recommend a wait-and-see policy, including ergonomic advice and prescription of pain medication if necessary. This trial

aimed to compare the efficacy of a wait-and-see policy with that of physiotherapy and corticosteroid injections at 3, 6, 12, 26 and 52 weeks.

Inclusion criteria were: adults with pain at the lateral side of the elbow for more than 6 weeks, increasing with pressure on the lateral epicondyle and with resisted dorsiflexion of the wrist and ability to complete questionnaires in Dutch. Exclusion criteria were well defined. Finally 185 patients that met all selection criteria were randomly assigned into three groups. The physiotherapy group consisted of nine treatments of pulsed ultrasound, deep friction massage, and an exercise program over 6 weeks. The corticosteroid injections group was treated by their family doctors with local infiltration of 1mL triamcino-loneacetonide (10 mg/mL) and 1mL lidocaine 2%. A maximum of 3 injections was allowed during the 6-weeks period. Patients in the wait-and-see policy group visited their family doctor once during this period. Activities that provoked pain and practical solutions (including ergonomic advice) were discussed with the patient. If necessary, paracetamol or NSAIDs were prescribed. The patient was encouraged to await further spontaneous improvement. The exercise program, the ultrasound and the injection procedures were well explained and reproducible.

Outcome measures included general improvement, severity of the main complaint, pain, elbow disability, and patient satisfaction. Severity of elbow complaints, grip strength, and pressure pain threshold were assessed by a research physiotherapist who was unaware of treatment allocation. The principal analysis of all outcomes was done on an intention-to-treat basis. At 6 weeks, corticosteroid injections were significantly better than all other therapy options for all outcome measures. Success rates were 92% compared with 47% for physiotherapy and 32% for wait-and-see policy. However, recurrence rate in the injection group was high. Long-term differences between injections and physiotherapy were significantly in favour of physiotherapy. Success rates at 52 weeks were 69% for injections, 91% for physiotherapy, and 83% for a wait-and-see policy. Physiotherapy had better results than a wait-and-see policy, but differences were not significant.

These results indicate that patients should be informed about the advantages and disadvantages of the treatment options for lateral epicondylalgia. If individuals prefer quick relief of symptoms, like athletes, a corticosteroid injection might be suitable, but the long-term outcome can be poor. A wait-

and-see policy, with adequate advice and pain medication if needed, will often suffice. The highest probability of recovery after 6 months, however, is associated with physiotherapy and in a less degree with wait-and-see policy. The physiotherapy protocol consisted of ultrasound, massage and exercises. Previous RCTs have proved that exercises are superior to pulsed ultrasound for long-term relief of tennis elbow. Thus, it is questionable if ultrasound had a significant contribution to the overall effect in physiotherapy group. This might also explain the small difference between physiotherapy and wait and see policy. Whether or not the surplus value of physiotherapy is worth the additional resources needed for treatment is debatable.

Study 4

Study title: The initial effects of an elbow mobilization with movement technique on grip strength in subjects with lateral epicondylalgia**.**

Journal: Manual Therapy (2001), 6(3): 163-169

Data base: from references of recent review article

Study type: Other Experimental study **Level of evidence**: level 3

Critical appraisal tool: The PEDro appraisal tool modified into 10 items **Study score:** 5/10

Summary/comments: The relevant background areas, the reliability of the outcome measures, the interventions and the purpose of this study were all discussed in detail in the introduction section. This experiment aimed: 1) to establish what proportion of tennis elbow patients correspond favourably to MWM, 2) to establish whether the pain-free grip strength or maximum grip strength improved after application of the MWM, 3) to compare the responsiveness of those two outcomes

and report the effect size of these measures in patients with lateral epicondylalgia.

Twenty five subjects were included if experienced lateral elbow pain with griping of resisted wrist of finger extension. Baseline characteristics ranged significantly concerning type of work, dominant **or** non-dominant arm and comparable sign. However the majority of patients (23) had chronic pain. Exclusion criteria were well defined. The comparable sign was the activity, of 8 preset activities, that reproduced patients' symptoms. Main outcomes were measured with a grip dynamometer.

The study protocol was accurately explained and reproducible. Patients were instructed to press the dynamometer short of pain and then as strong as they could. Measurements took place for both sides randomly selected. The primary investigator conducted the physical tests and interventions, but was blinded in the dynamometer measures. He also applied the MWM. After intervention subjects that mentioned decrease in pain (compared with pre-intervention comparable sign) were allocated to group one. Those that didn't have pain elimination were allocated as group two.

The data analysis methodology was properly explained and statistical calculations appropriately applied.

The study results indicated that MWM was effective in 92% of the population. Subjects were able to perform previously painful activities pain-free, and improved their grip strength immediately after intervention. These pre-post test improvements were significant. Pain-free strength increased by a greater magnitude than maximum grip strength.

In the discussion section, study results were compared with outcomes from other similar studies and the authors showed awareness of the limitations of this trial. Implications for further research also suggested as appropriate.

We can conclude that MWM is a promising therapeutic tool for the treatment of tennis elbow patients. It is also evident that pain-free grip is more reliable measure of outcome to assess patients suffering from tennis elbow. However further research is needed to investigate the long-term effectiveness of Mulligan MWM in the rehabilitation of disability resulting from lateral epicondylalgia.

Needless to mention that the low scoring of this study still questions the overall effectiveness of this

intervention for tennis elbow and future trials should commence, of better methodological quality and more participants, to be able to support a strong opinion for this therapeutic tool.

Study 5

Study title: Iontophoretic Administration of Dexamethasone Sodium Phosphate for Acute Epicondylitis.

Journal: The American Journal of Sports Medicine (2004), 32(2): 462-469

Data base: The PEDro Physiotherapy Evidence Database

Key words: Tennis Elbow, Randomized Controlled trial, Physical therapy, Conservative, Physical Means

Study type: Randomized, Double-Blinded, Placebo-Controlled Study **Level of evidence**: level 2

Critical appraisal tool: The PEDro appraisal tool modified into 10 items **Study score:** 9/10

Summary/comments: The background of this paper referred mainly in the incidence of epicondylitis and the main pathophysiological characteristics of the condition. However, the authors didn't refer to other similar past studies and didn't mention if this trial was novice. The purpose of this study was to evaluate the safety and effectiveness of dermal iontophoretic administration of dexemethasone sodium phosphate 0.4% injection compared with a placebo of saline solution for the treatment of acute epicondylitis. Participants included if they have clinical signs leading to lateral or medial

epicondylitis diagnosis, moderate or grater intensity of symptoms and duration of three or less months during the last episode. Exclusion criteria were well defined.

Finally 199 patients were allocated into the dexemethasone and the placebo groups. Allocation was randomized through computer software to ensure equal distribution of baseline characteristics in both groups. Each patient received six sessions of 40 mA-minutes each of treatment within a 15 days timeframe or less. The application of the device was thoroughly detailed to be repeatable. The main outcome measures were treatment efficacy, adverse reactions, and VAS scales. The efficacy included investigators and patients evaluation of improvement through questionnaires. Both patients and investigators were blinded to type of treatment. A reasonable explanation of the results took place. Dexamethasone produced a significant 23-mm improvement on the 100-mm VAS patient scale, compared to a 14-mm for the placebo at 2 days and 24-mm compared with 19-mm at 1 month follow-up. Significant decrease in symptoms scored the dexamethasone group at 2 days, on the investigators improvement scale (52% versus 33%), but no significant deference in the 1 month follow-up (54% versus 49%). Patients that completed the 6 sessions within 10 days or less showed better results than those treated over a longer period.

However this paper wasn't entirely directed to tennis elbow, it was included in this bibliography for two reasons; because of its high quality and because iontoforesis is a very common treatment modality for lateral epicondylitis. Consequently, however results were satisfactory, we can't assume that would be the same if both groups were consisted exclusively from tennis elbow sufferers. They could be worse or better. The methodology of this study was very good but didn't record patients' functional ability with a relative questionnaire. This would make the results more suitable to daily practice where we assess patient's pain and functional ability as well. Another limitation of this trial was that it didn't specify patients' functional levels and other contributing factors like type of occupation etc. The functional level before intervention (very relative to type of occupation as well) and after, would give some space for better understanding of the results. This study concluded that iontoforesis treatment was well tolerated by most patients and was effective in reducing symptoms of epicondylitis at short-term follow-up.

We can conclude that iontoforesis can offer short-term relief, but should not forget that these results were observed in acute situations, thus can not be generalized for chronic sufferers.

Study 6

Study title: Non-steroidal anti-inflammatory drugs (NSAIDs) for treating lateral elbow pain in adults (review)

Journal: The Cochraine Collaboration, 23 October 2001, issue 4

Data base: The PEDro Physiotherapy Evidence Database

Key words: Tennis Elbow, Randomized Controlled trial, Physical therapy, Conservative, Physical Means, NSAIDs, injection

Study type: Systematic Review **Level of evidence**: level 1

Critical appraisal tool: The Greenhalgh appraisal tool modified into 6 items **Study score:** 6/6

Summary/comments: The purpose of this systematic review was to assess the effectiveness of NSAIDs (oral or topical) in the treatment of adults with lateral elbow pain, with respect to pain reduction, improvement in function, grip strength and adverse effects. An extended search of relevant background data reported lack of evidence for the efficacy of NSAID in the treatment of

tennis elbow at that time.

Investigators searched the Musculoskeletal Review Group's trials register data base, the Cochrane Clinical Trials Register, MEDLINE, CINAHL, EMBASE and SCISEARCH up to June 2001. Only RCTs were of interest comparing NSAIDs vs placebo, or another modality, or of varying types and dosages of NSAIDs in tennis elbow patients who suffered for more than 3 weeks. Relevant outcome measures of interest were pain at rest and with activities and resisted movements, movement of the elbow, function/disability, quality of life, grip and elbow strength, return to work, performance at sport and adverse effects.

Two reviewers independently applied selection criteria and assessed study quality. Finally 14 trials were included in this review. Only **a** few trials used intention to treat analysis and the sample size of most was very small. The median follow up was 2 weeks (range 1-12 weeks). It was evidenced that topical NSAIDs were significantly more effective than placebo with respect to pain (difference= -1.88, 95%CI -2.54 to -1.21) and patients' satisfaction (relative risk 0.39, 95%CI 0.23 to 0.66) in the sort-term. But this data was extracted from unblinded trials and the possible publication bias was mentioned by the authors. The adverse effects reported were minor.

Only two trials identified assessing the effect of oral NSAIDs and these were not able to be pooled. There was some evidence for sort-term relief of pain and function improvement, but these benefits wasn't sustained. Significantly, this category reported more gastrointestinal adverse effects (relative risk= 3.17, 95%CI 1.35 to 7.41). Some advantage may be evident with steroid injection over oral NSAIDs (patients perception of benefit relative risk=3.06, 95%CI 1.55 to 6.06), but this wasn't sustained in the long-term.

Only one trial included in this review followed participants for more than one month and subsequently no conclusions can be drawn regarding the long-term effects of NSAIDs in the treatment of this often chronic condition.

The reviewers concluded that topical NSAIDs had been shown to offer at least short-term (up to 4 weeks) benefit in improving symptoms in tennis elbow patients. Adverse effects were minor.

However there was confiding evidence for the use of oral NSAIDs and no direct comparisons between oral and topical use were available.

We can conclude that more RCTs are needed before conclusions can be drawn, concerning the efficacy of NSAIDs in the treatment of lateral epicondylalgia, with respect to oral NSAIDs. Future trials should use blinded outcome assessors, intention to treat analysis, and preferably follow participants for longer than 4 weeks to determine the effectiveness of NSAIDs in the longer term.

Study 7

Study title: Orthotic devices for the treatment of tennis elbow (review)

Journal: The Cochraine Collaboration, 21 January 2002, issue 1

Data base: The PEDro Physiotherapy Evidence Database

Key words: Tennis Elbow, Randomized Controlled trial, Physical therapy, Conservative, Physical Means

Study type: Systematic Review **Level of evidence**: level 1

Critical appraisal tool: The Greenhalgh appraisal tool modified into 6 items **Study score:** 6/6

Summary/comments: This systematic review aimed to determine the efficacy of treatment of tennis

elbow by an orthotic devise. In the background section of this review other studies were thoroughly reported concerning the intervention tested and different applications. It was concluded that many different types of braces and orthotic devices were available for treating tennis elbow.

Theoretically, binding the muscle with a brace may limit the expansion of muscle fibers and decrease the contribution to force production made by muscle fibers proximal to the hand. Immobilization should completely limit expansion and no force can be made by the muscle fibers.

MEDLINE, EMBASE, CINAHL data bases were reached with no limitations to language. To be included, studies should be randomized or controlled trials with or without blinded investigators. Follow up should be at least 1 day. Participants should at least have increased pain with compression over the lateral epicondyle and resisted wrist dorsiflexion. A variety of interventions was allowed such as orthotics, braces, splint casts, bands or straps. Control interventions could be any form of conservative treatment. Outcome measures could include: pain, global measure improvement, elbow-specific functional status, maximum grip strength, pain-free grip strength, generic function status or pressure pain on the lateral epicondyle.

A thorough evaluation of available studies took place concerning methodological quality and validity. Two blinded reviewers independently extracted the data regarding the interventions, type of outcome measures and follow up assessments. Many low quality studies were identified initially. By contacting with the authors, studies' scores increased significantly. This implicated that poor reporting and no lack of methodological quality was the reason of poor quality studies.

In respect of the inclusion criteria only 5 RCTs were included in this review. The following comparisons took place amongst RCTs: 1) orthotic devices vs other conservative treatment, 2) orthotic devices as an additional treatment, 3) orthotic devise vs another orthotic device. Heterogeneity amongst trials, concerning type of orthotic devise and study population was observed. Thus pooling wasn't possible. The small number of trials did not allow subgroup analyses. In addition to this, only one out five presented intermediate-term and long-term results and the highest number of relevant outcome measures were 3. No functional outcome measures like Pain Free Function

Questionnaire were reported.

The authors acknowledged that despite their extensive research, possible relevant trials might was missed. That's why they planned to update this review if additional eligible trials were found.

It is obvious that more well-designed and well-conducted RCTs of sufficient information have to be conducted before we conclude the effectiveness of orthotic devices for the treatment of lateral epicondylalgia.

Study 8

Study title: Shock wave therapy for lateral elbow pain (review)

Journal: The Cochraine Collaboration, 21 January 2002, issue 1

Data base: The PEDro Physiotherapy Evidence Database

Key words: Tennis Elbow, Randomized Controlled trial, Physical therapy, Conservative, Physical Means, Lateral Elbow Pain

Study type: Systematic Review **Level of evidence**: level 1

Critical appraisal tool: The Greenhalgh appraisal tool modified into 6 items **Study score:** 6/6

Summary/comments: This systematic review aimed to determine the effectiveness and safety of extracorporeal shock wave therapy (ESWT) for the treatment of adults with lateral epicondylalgia. In the background section of this review a thorough report of other relevant studies, the intervention tested and different application approaches within literature took place. It was revealed that controversy exists if high or low-shock waves should be used, or if they have to be applied directly on target areas and whether local anaesthetic should be used to decrease painful reactions. Shock waves are single pulsed acoustic or sonic waves, which dissipate mechanical energy at the interface of two substances with different acoustic impedance.

Relevant citations were included if they were good quality RCTs comparing ESWT with placebo or other groups or of varying types and dosages of shock wave, it had only adult participants with lateral elbow pain located on the lateral epicondyle and no other systemic conditions or previous trauma. RCTs published in other languages than English were also translated and included in this review. A variety of outcomes were included within studies, including pain at rest and with activities and resisted movements, movement of the elbow, function/disability, quality of life, grip and elbow strength, return to work, performance at sport and adverse effects.

Multiple key words in various data bases such as MEDLINE, CINAHL, EMBASE and SCIRESEARCH were combined. The identified clinical trails were review and assessed for their validity by two independent investigators. The validity was assessed as: adequate, unclear or inadequate. Meta-analysis of raw data took also place to assess efficacy where available in the published reports.

With respect to the inclusion/exclusion criteria only two trials comparing ESWT versus placebo therapy were included. Both trials concluded of similar populations suffering from chronic symptoms who had failed other conservative treatment. Both citations included equal doses, similar technique and frequency of application. The first trial demonstrated highly significant differences in favour of ESWT whereas the second trial didn't find ESWT superior to placebo treatment.

When data from the included trials were pooled no more benefits observed in the first study. The relative risk of treatment failure of ESWT over placebo was 0.40(95% CI= 0.08-1.91) at 6 weeks and 0.44 ((95%CI= 0.09-2.17) at one year. After 6 weeks, in VAS pain scales out of 100, there was no

significant improvement in pain at rest (-11.40, 95%CI= -26.10 to 3.30), pain with resisted wrist extension (-16.20, 95%CI= -47.75 to 15.36) or pain with resisted middle finger extension (-20.51, 95%CI= -56.57 to 15.56). After 12 and 24 weeks the results were similar.

Thus, because the two trials included in this systematic review showed conflicting results, there is not enough evidence, at present, to show whether shock wave therapy can help tennis elbow. Further, good quality, trials are needed to clarify its value.

Study 9

Study title: Surgery for lateral elbow pain (review)

Journal: The Cochraine Collaboration, 21 January 2002, issue 1

Data base: The PEDro Physiotherapy Evidence Database

Key words: Tennis Elbow, Randomized Controlled trial, Surgery, Release Surgery

Study type: Systematic Review **Level of evidence**: level 1

Critical appraisal tool: The Greenhalgh appraisal tool modified into 6 items **Study score:** 6/6

Summary/comments: This systematic review aimed to determine the effectiveness and safety of

surgical interventions for the treatment of adults with lateral epicondylalgia with respect to symptom reduction, improvement in function, grip strength and return to work/sport. In the background section of this review a thorough report of other relevant studies and different surgical approaches within literature took place. Between them, authors identified three main categories of surgical treatment with respect to deferent pathologies that cause lateral elbow pain. These are: 1) excision of lesion within the origin of ECRB and/or release of the ECRB from the lateral epicondyle region, 2) release of the posterior interosseous or radial nerves, and 3) percutaneous release of the lateral epicondyle muscular attachments.

With respect to the evidence hirierchy this review aimed to include only RCTs and pseudo RCTs published in all languages. Participants should be adults, with relevant symptoms for more than 3 weeks, no history of relevant surgery or trauma and other systemic disease. Each study should include at least one surgical intervention vs no treatment or placebo, another modality, or another surgical procedure to allow comparisons.

Comprehensive electronic searches of MEDLINE, CINAHL, EMBASE and SCISEARCH were combined with searches of the Cochrane Clinical Trials Registar and the Musculoskeletal Review Group's specialist trial database. Searches were conducted up to October of 2001.

Two independent reviewers assessed all identified studies with respect to pre-set inclusion/exclusion criteria. Validity of included trials was assessed based on whether studies had appropriate randomization, allocation concealment, blinding, drop out rate at long-term follow up and intention to treat analysis. The scoring ranked as adequate, unclear or inadequate.

No studies were identified which met the inclusion criteria for this review at that time. Only one possible study was identified of better methodological quality. However this study failed as well to meet the inclusion criteria as the surgical intervention was not randomized and there was not appropriate comparison group.

It was mentioned that there is no evidence to either support or discourage the use of surgical interventions for lateral elbow pain. Patients that undergo surgical procedures for lateral

epicondylalgia should do so in the knowledge that it is an unproven treatment modality for this condition. We can conclude the unquestioned need for RCTs comparing surgical approaches to no treatment or other conservative interventions, with long-term follow ups, before any conclusions can be made about the role of surgery for lateral elbow pain.

Study 10

Study title: Physiologic Consequences of Surgical Lengthening of Extensor Carpi Radialis Brevis Muscle0Tendon Junction for Tennis Elbow

Journal: The Journal of Hand Surgery (1994), 19A: 269-274

Data base: CINAHL

Key words: Surgery, Tennis Elbow, Lateral Epicondylitis

Study type: Other Experimental study **Level of evidence**: level 3

Critical appraisal tool: The PEDro appraisal tool modified into 10 items **Study score:** 2/10

Summary/comments: This study aimed to experiment the effectiveness of surgical lengthening of the ECRB muscle-tendon junction in tennis elbow patients. The authors mentioned all relevant studies background and defined well the aims of the study in the introduction section. 3 men and 2

women were included in the study. However the criteria by these patients were classified as tennis elbow sufferers and any relevant clinical test for pre-post operative comparisons wasn't mentioned. Furthermore baseline characteristics were absent.

The outcome measures were sarcomere and filament lengths and the consequences that will have in the muscle-tendon passive and active tensile forces and pain response in three different wrist positions; neutral, full flexion and full extension. For the purpose of this study a new intra-operative Laser device was detailed introduced. Repeatability of sarcomere length measurements between observers was determined by sequential blinded measurement of diffraction patterns obtained from muscle biopsies. The surgical intervention and the overall experimental protocol were well explained and reproducible.

Statistical analysis methodology was appropriately discussed. From the five included patients 4 were completely cured after 6 weeks following the surgery and one reported residual symptoms lasting 3 months post-operatively. From this point we can assume that the main clinical outcome was pain. It was also mentioned that patients did not report difficulty to perform DLAs.

Pre-operative measurements indicated that ECRB muscle developed near-maximal isometric force at full wrist extension, decreasing to 20%^ maximum at full flexion. The 9.1 (+/- 0.88)μm stair-step surgical tendon lengthening of the ECRB resulted in a mean ECRB sarcomere shortening of 0.30μm. This shortening was predicted to have two primarily biomechanical effects: 1) 25% decrease in muscle passive insertional tension, thus decrease in pain, and 2) 25% increase in active muscle force. This opposed to previous studies that mentioned muscle weakness with tendon lengthening. Results were detailed interpreted in the discussion section. However we can't generalize these results for five main reasons:

I. the study sample was very small to support a statistical significant and reliable result,

II. there was no control group. A placebo surgery would be unethical. Orthotics devices such as forearm braces tend to reduce tensile forces on the common extensors origin region. Thus such a group would be appropriate to form the control group,

III. we don't know how similar were the participants in key baseline characteristics,
IV. there wasn't included in the main outcomes pain scales, patients' satisfaction, functional ability, pain free grip, return to work/sport etc.,
V. only the short-term effects of this experimental approach were encountered. However the extent of which the ECRB muscle it self would remodel and adapt following the surgery and respond to future loads, especially in athletic populations is unknown.

The low quality of this experimental study, questions the reproducibility of its results in general population and implicates the need for more recent, better quality trials, concerning the surgical approach of lateral epicondylalgia, that include in their outcome the long-term effects as well.

The limitations of this search strategy are:

papers published only in English language were included

studies included, could be reached only through Adelaide libraries and UniSA IT service (publication bias)

well promising therapeutic interventions such as combination of eccentric exercises and stretching, which were mentioned in low quality or "old" papers, were not included in respect to the inclusion criteria.

Summary

This review paper showed that corticosteroid injections might be suitable in athletic populations who seek for quick relief. NSAIDs had been shown to offer at least short-term (up to 4 weeks)

benefit in improving symptoms. However the effectiveness of oral or topical use is still questioned. From a manipulative perspective, MWM seems like a promising therapeutic tool in the short-term management. Acupuncture can also be beneficial but only for the first 24 hrs. The same counts for iontoforesis, whereas ultrasound, laser and shock wave therapy show poor results. The effectiveness of forearm braces is still controversial.

A wait-and-see policy, with adequate advice and pain medication if needed, will often suffice. The highest probability of long-term recovery, however, is associated with physiotherapy consisting of specific wrist exercises and stretches as they involve patients actively into self management. There is no evidence to either support or discourage the use of surgical interventions for lateral elbow pain. Patients that undergo surgical procedures for lateral epicondylalgia should do so in the knowledge that it is an unproven treatment modality for this condition.

The most sensitive and reliable clinical findings to diagnose tennis elbow and set a baseline from which the treatment outcome can be determined are:

pain with palpation located on the lateral femoral epicondyle

positive forced elbow extension test (pain on lateral femoral epicondyle and limited ROM when from elbow-flexion, forearm-full pronation and wrist-palmarflexion, the clinician drive elbow into extension)

resisted extension of the middle finger with resistance given at the head of the proximal phalanx. This test is applied with patient's elbow in 90º flexion and forearm fully pronated. It focuses particularly on the ECRB muscle and is positive if it reproduces patients symptoms

pain free grip force, measured by a dynamometer

visual analog pain scales (0-10 numbers or 0-100 cm)
functional ability scales like the Oswestry Disability Index (0-100%)

Case management

The above mentioned examination and treatment interventions are referenced in the following case report. This case is about a mechanical engineer. George is an active healthy 38-year-old male. He is right hand dominant and enjoyed every weekend playing golf with his brother-in-law before the onset of his elbow problem. George has been practicing his profession for about 18 years. The first ten years, before he become very popular in the related working industry, he was doing to much manual work involving lifting heavy objects; working many hours under big factory engines, screwing etc. The last eight years he has become the first engineer in a big factory that employees more than 150 people. His relationship with his colleagues is excellent. He supervises 10 mechanical engineers; thus except from the responsibilities of his position, he doesn't have any heavy manual duties.

Six months ago the second engineer had to travel in Europe in another factory of the same business. There was a mechanical project to be done by the end of the month. There wasn't time left to employee other staff. The project was novel and had to be kept under trustful personnel. He really loves his job and especially "playing" with machines. So he volunteered him self with the manual demands of that project. Moreover, the most demanding and skilful tasks are to be done from the second engineer 'cause the machine body parts are very expensive and unique. During that period of time he was feeling bit of soreness on his right elbow

after work that subsided during the rest of the day. In the mornings he was alright but since he was involved in manual work, especially loosening corroded nuts his was experiencing difficulty because of elbow sureness.

He didn't pay to much attention to it and on the weekend he went for his usual golf game. He also felt that soreness at his first T-off but after a while it was feeling ok. While he was attempting a long ball, at the follow through he experienced a sudden on set of shooting pain on his elbow. He stopped and after an hour he became aware of moderate lateral elbow pain even with gripping the car steering wheel. That coming week he continued the manual work as there was no replacement. Pain gradually increased and at the end of the week was severe with any heavy gripping activity. Being active and in a very responsible position at that time he continued working for further one week till the second engineer returns to his position. He then visited his family doctor and was prescribed NSAIDs for 4 weeks. He didn't really notice a great difference to his pain. He didn't do any manual work anymore, but every time that he was typing the weekly report (approximately 10 min) he was feeling a moderate pain on the lateral elbow side that forced him to stop. He was very protective with playing golf at that period because that activity initiated, to his belief, his inability to work. But he was anxious as well because golf was his primary interest at his days off. So his doctor applied a series of local corticosteroid injections around the area of the common extensor origin. For the next 2.5 months, after the injection his pain reduced slightly and was coming up again with the same intensity (moderate to severe) depending on his daily activities.

His wife had a very goof friend that happened to be a surgeon. They visited him for a second opinion. The doctor referred them to a hand specialist and he suggested, he should get a neck X-ray. The images were clean and he advised him that if he wanted complete symptoms relief, he should consider doing a small surgery that wouldn't take him more than half a day in the hospital. He didn't have any working issues since the second engineer would be assuming his duties, so he accepted the advice.

The surgery was planned for after two weeks. In that clinic I was also working as a physiotherapist.

The surgeon provided me with the above mentioned brief summary of Dimitris's history. On that time I showed Dimitris. I explained him that I had to take a basic history report and do a thorough physical examination so we can have a baseline of symptoms and functional ability, to compare with after the surgery result.

The **basic subjective examination findings** were:

Area of symptoms	right lateral elbow area-just above the lateral femoral epicondyle
Characteristics of symptoms	ache diffuse pain
Activity capability/restriction	loosing corroded nuts typing for more than ten minutes currying bags from super market writing with a pen brushing teeth any gripping activity in general
Participation	can't work efficiently

capability/restriction	cant play golf cant help his wife with shopping
Patient's perspective on their experience	feels anxiety cause didn't pay to much attention from the beginning and now have to go on surgery feels that golf was responsible for his condition and if he didn't play he would have managed the situation better bit worried if he is going to play golf in the future
Behavior of symptoms	Aggravating: any gripping activity Easing: rest corticosteroid injections (bit of short-term relief)
24 hour pattern	AM: no morning stiffness, unless had slept with arm under body DD: depended aggravating activities like squeezing or gripping actions ED: depended on DD activities/night only if turn on right elbow
Precautionary questions	no headaches/no VBI symptoms/ no spinal cord symptoms
Screening questions	no tingling or pins and needles down the arm no neck problems neither thoracic or scapular pains pain doesn't not relates with arm or neck movements was feeling sometimes right hand side fingers colder

	than left side
	no other health issues
Tabs	NSAIDsà did not make big difference
	4 Corticosteroid injections within 2.5 monthsà temporary short-term relief
Psychosocial issues	no family issues-positive working environment
History	incidious on set pain during manual work at factory
	gradually increased in frequency/intensity
	sudden onset of sharp/knife like pain during follow through after long golf ball
	exacerbation since then
Past history	shoulder pain when was 28 years old during a big demanding manual project
Diagnostic imaging	X-ray on cervico-thoracic level: clear

Clinical reasoning

The possible sources that can generate pain on the lateral elbow side are:

local joints; the radioulnar and radiohumeral joints

the musculotendinous elements; especially the common extensors origin of the wrist and the fingers

neural structures; specifically the radial nerve (RTS) and the posterior interosseous nerve

the lower cervical spine; especially the C5-C6, C6-C7 segments that can refer pain at the lateral elbow via dermatomes and sclerotomes and myotomes (Ekstrom and Holden 2002).

The fact that pain comes on with specific activities and eases with rest, reveals a mechanical nociceptive pathobiological process most dominant. This could be generated from nociceptors in the joints, musculotendinous structures and the nervi nernorum of local nerves. The fact that pain is not present at resting positions, neither is related with neck or arm movements, doesn't really indicates a low cervical pathology that contributes to the symptoms. Furthermore, the clear X-ray reinforces my opinion. Thus, peripheric neurogenic mechanisms are unlikely to be found. However that doesn't mean that I am not going to perform a quick screening of the neck at first day or that I won't do the neurodynamic tests, especially the ULNT2b which biases to the radial nerve. This is because in chronic situations like this (five months on going symptoms), central sensitization and peripheral hypersensitivity (neurogenic inflammation, secondary hyperalgisia, free nerve endings on regenerated scar tissue) take place (Butler 2000, Butler and Moseley 2003). An asymmetry of ROM or pain response will probably indicate that. Furthermore, no-night pain or numbness with sustained postures doesn't indicate vascular contribution to patient's complaints.

The 24 hr pattern doesn't indicate a possible inflamatory state. This is reinforced as well with the fact that NSAIDs and corticosteroid injections didn't really help. The temporary relief with the injections might indicate a minor local inflammation which was generated from repetitive microtrauma of the common extensors tendons origin, especially the ECRB. This is already known as the original initiation

of tennis elbow and is well reported from the literature (Ekstrom and Holden 2002, Vicenzino and Wright in Abbott et al 2001).

The colder fingers feelings on the right hand side fit with a sympathetic reaction, which is pretty common in chronic pain situations. Furthermore, sympathetic trunk can be compromised from thoracic pathology (Phund and Kalterborn 2004). This indicates that examination of the upper thoracic spine should be included as well. During this short subjective examination, I didn't observe

any poor posture, so I wouldn't prioritize thoracic mobility at day one.

I asked about headaches and all five VBI symptoms in particular because the APA guidelines indicate that they have to be screened for safety issues when the neck or upper limb is going to be mobilized. Since no other health issues were present, I didn't have any reason to limit in any form my physical examination.

George visited me with his wife. They looked quite happy together and his wife seemed worried about her husband. Their children were healthy. I concluded that no family issues were present at the moment, and since working environment was well supportive, I didn't have any reason to think of possible yellow flags. His high activity level (good conditioning), his willingness to return to golf (motives/targets), his age (young; thus good healing) his supportive environment and the absence of financial issues (in Greece, golf is kind of rich peoples' hobby) were all promising a good post-operative response.

The surgery would be lateral extensor tendon release. The local skin and deeper tissues are infiltrated with 1% lidocaine and 1:10000 epinephrine. A gently curved incision, approximately 5 cm long is made over the lateral epicondyle. Patient retains muscle control during the surgery; in some point he would be asked from the surgeon to "cock up" his wrist, so that the exact area of release would be defined. The joint capsule would be released as well as it blends extensively with the extensors origin. During this position a small incision is also made on the synoveal membrane to investigate the radiohumeral joint to exclude intra-articular lesions (Verhaar et al 1993). Therefore, because the surgery was small and the

chronicity of the condition wasn't that much; I didn't really worry about post-operative CRPS1.

The insidious on set of symptoms fits with tennis elbow. The sudden on set sharp pain to my belief was a tearing probably of the extensors musculotendinous region. That doesn't mean that the tennis elbow initiated at that moment. Microtrauma was constantly happening at that region since George started the manual working again. There were many years passed since he last had done any working specific manual activity. That indicates that his tissues weren't ready for the "new" demanding task. So microtrauma was happening gradually with no adequate time to heal for two reasons: 1) tendons don't have enough blood supply and 2) George continued to do the aggravating manual activity. During follow-through phase in golf, the right elbow and wrist extensors contact eccentrically to decelerate the club motion. Thus, because the tissues were already degenerated and their tensile strength was compromised, a musculotendinous tear might happen at the long ball moment which added to the whole picture. This could indicate a faulty golf technique as well. However, the fact that for the last 5 years George was playing golf with no similar symptoms doesn't fit with that scenario. I would probably do some technique screening before I sent him back to his hobby, at the final rehabilitation stage to prevent future problems.

The shoulder pain in the past would probably be a subacromial impingement which responded well to rest. This is because George demonstrated some overhead activities that he was doing at that time. Since, he didn't have any other symptoms after that short period and his recent history didn't mentioned or demonstrated any overhead activities I wouldn't worry to focus on the shoulder at present. However I would commence a quick screening. This is part of the neurodynamics testing. A rough check of active/passive movement of every joint is essential to prevent any false negatives-positives during neurodynamics testing (Butler 2000).

The fact that George was a bit frustrated at that moment with the scheduled surgery and mostly for the outcome and his ability to play golf again, a summary of the findings and a logical explanation of his symptoms at the end of the physical

examination would be beneficial. It wasn't my responsibility to talk about the surgical details, so if George had any questions about the procedure he would be referred to the surgeon again. Actually, I wasn't positive with the immediate decision of the doctor to commence the surgery. This is because there is no current high evidence for the efficacy of any surgical procedure on tennis elbow pathology (Buchbinder et al 2002, Verhaar et al 1993). However, long term follow-ups don't indicate post-surgical aggravation, so I didn't really have serious reasons to worry about that.

Subjective examination lasted approximately 20 min. I had still 25 min to do some physical examination stuff. My first day, pre-surgical physical examination priorities and main findings were as follows:

(*George was sited on the bed*)

Palpation: George indicated from the beginning of the subjective examination his most painful spot over the lateral femoral epicondyle. Palpation revealed **P1=6/10 at a grade II+ direct pressure**. With more pressure pain was significantly raise with no obvious resistance or spasm. Pain was also **spreading to the surrounding area, approximately 3cm in diameter**. Palpation of the radial canal revealed some discomfort as well radiating down the dorsal side of the forearm, wrist and fingers that George was unaware of, but wasn't significant.

Elbow extension test: George was instructed to let me know when he will feel his first pain. With the elbow initially in 90º of flexion, I introduced full forearm pronation and wrist PF. Minor discomfort initiated with wrist PF (P1= 2/10). Further elbow extension increased symptoms gradually and reached a state of **P=5/10 at 30º elbow flexion.** At that position neck movements didn't make any differences, whereas shoulder movements into full flexion/abduction, while I was holding the wrist and elbow stable at P1, increased slightly George's pain.

resisted extension biased to ECRB: with George's elbow in 90º flexion and forearm fully pronated and fingers in neutral I instructed him not to let me bend his middle finger. **Pain**

5/10 came very fast with a 50% resistance. The same test on index finger produced less pain.

pain free grip: was measured by a dynamometer in the same starting position as above. The dynamometer measured 19.5Kg before pain comes on. The other side was measured 33Kg maximum grip and it was pain free.

hands behind back/over head/on contralateral scapula were pain-free and normal.

(patient lied on his back)

His right **forearm** in the resting position was relatively more **pronated** from the left (shortened pronators/wrist flexors) and his passive supination was decreased compared to the other side.

Elbow passive and active **movements** were pain free generally. Only supination with resistance in elbow 90º flexion was weak and painful; supination with flexed wrist was more painful. Elbow quadrant biased to radiohumeral and humeroulnar joints was pain free as well. Radiohumeral joint play was normal and slight pain raised from my pressure to the surrounding area (I had placed my hands very close to the joint).

Neurodynamic tests were nearly **symmetric**. Only the ULNT2b (biases on radial nerve) had limited wrist PF. The rest caused some superficial local lateral elbow pain from the elbow and wrist movement. On P1 release of shoulder depression, or head rotations did not make any difference.

George had a good overall posture. Only slight curved shoulders and a bit protracted neck with decreased cervical lordosis were observed, but they were minor. Closing type movements, such as rotation to the right-right side flexion-extension of the neck and opening type like flexion-left side flexion-left rotation did not referred any symptoms down the arm and did not reproduced George's symptoms.

Clinical reasoning

The positive tests specific to lateral epicondylalgia on the pathologic right side indicate definitely a

moderate to severe chronic tennis elbow. The left hand side was symptom free. Radiating pain with palpation is common finding in painful situations. The radiation was symmetric and did not follow a specific nerve root or dermatome, that's why it is determined as general secondary hyperalgisia. The pain pattern confirmed my initial hypothesis for mechanical nociceptive primal pain

mechanism. The tender radial tunnel indicates possible: 1) hypersensitivity of the nervi nernorum of the radial nerve of PIN due to increased chronic pressure of the nerves within the tight supinator muscle, or 2) a minor local neurogenic inflammation due to repetitive microtrauma, that has decreased the threshold of firing of the nerve. Moreover, subjective examination didn't indicate symptoms radiating down the arm that are common in nerve entrapment syndromes of the elbow (Behr and Altchek 1997).

In the elbow extension test if pain had changed with arm or neck movements it would indicate brachial plexus dysfunction contributing to symptoms or cervical spine pathology. The negative neurodynamic testing and neck provocation tests confirmed this. Those, in addition to the pain free arm and elbow movements exclude the possibility of somatic referred pain to the lateral elbow region or other scenarios such as double-crush etc.

The asymptomatic elbow quadrant and less painful joint play didn't indicate intra-or capsular joint structures pathology. Less pain with resisted index finger isometric contraction differentiated ECRL from ECRB pathology. Pain on resisted supination was coming mostly from the extensor origin and less from the supinator muscle (or compression of the radial nerve). Different pain responses in different wrist positions confirmed this hypothesis. Weak supination was caused mostly from pain inhibition, but the pronated forearm, in resting supine position, revealed pronators shortening due to chronicity of condition. Mack (1997, 2005) has proposed that abnormal bones posture and related muscle function around the elbow joint and upper extremity; may is a factor in the development and maintenance of symptoms in tennis elbow. This is a very common finding in

tennis elbow and contributes to the wrong pulling of the ECRB tendon in griping and other loading activities. However, the surgery would give a clear image of the exact pathological structures. Spinal postural changes were minor and didn't contribute to George's symptoms.

After this quick examination I had approximately 5 minutes. I gave him a reasonable explanation of the history of his symptoms and the most possible

pathobiological process. It was very easy for him to follow me because he was already well informed by the surgeon. Therefore, I skipped that part and explained him my findings and how we were going to use those asterisks to record progression after surgery. When we finished he didn't have any questions. I gave him an Oswestry Disability Index. I asked him to fill it out and return it to me the next day. I advised him to save 30 min of his time for next day because I wanted to show him some stuff. He and his wife seemed very pleased with my interest and he ensured me that he was going to be on time the next day.

The plan for the next session was to give him some Mulligan mobilizations with movement for tennis elbow. MWMs consist of lateral elbow glides with pain free grip. Literature suggests that MWMs are a promising technique in short-term relief from tennis elbow (Abbott et al 2001, Kochar and Dogra 2002). The principle of this technique is that by repositioning the elbow joints; in particular the radiohumeral, the abnormal pulling at the wrist and finger extensors is decreased, thus grip becomes pain free (Mulligan 1992). It was a good opportunity for me to test this technique on George's elbow. If it worked it would be of benefit for two basic reasons:

1) decrease of pain would desensitize the elbow region. If George was going to surgery with less pain, he would probably experience less pain post-surgically and the return to pain free activities would be shorter and

2) pain free grip as a home exercise would recondition the weak supinators-wrist and fingers

extensors muscles and their post-surgical recovery would be quicker.

Day 2 (pre-surgery)

Nothing from his asterisks had changed. Only his pain free grip was a bit weaker because he did some typing in the morning and it was a bit sore at that moment. I explained that the literature supports that one of the main causes of his problem is wrong pulling of the wrist and fingers extensors. I also explained him what I was supposed to do with the MWMs.

I applied the technique with George in supine lying position on the bed. He was able to perform 10 pain free grips and he was very excited. On reassessment his pain free grip improved to the baseline levels, but the rest of asterisks were the same. We ended this session with massage on forearm flexors and stretches. I showed him how to do self-MWMs with a belt. I told him that in any case this exercise should be pain free and afterwards pronators stretches should follow. He should also do the exercise every time he was feeling pain at work with typing and other aggravating activities. I explained him the possible benefits of this exercise and I arranged him another 30 min follow-up 5 days prior surgery.

Day 3 (pre-surgery)

S/E: all asterisks except to resisted middle finger extension had slightly improved. Pre-operative Oswestry Disability Scale score was 28%

Management:

MWMs: 10 pain free grips plus wrist extension-flexion

myofascial release massage over flexors/pronators
stretches to P1

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forced elbow extension improved to 30º (P=3/10)
pain free grip measured 22.1Kg
palpation revealed no difference
pronators were less tight (forearm was sitting in a better resting position)

The surgeon informed me that he released the intermuscular septum between the ECRB and the ED muscles. The extensor origin was further released from the lateral epicondyle. During this surgery only subcutaneous tissues and the skin were sutured. The doctor advised George from the next day to keep closing and opening his elbow often during day and to avoid aggravating activities for the next 2 weeks. Two weeks after surgery the sutures were removed and he was referred to me for exercise therapy.

Week 2 (post-operative)

S/E: looked pleased with the result. He had some pain that didn't feel like the old one.

P/E:

forced elbow extension P=5/10 to 20º with a bit of increased resistance. Elbow extension with wrist/forearm in neutral reached 5 with soft end-feel. There was no differenced with palmar-flexed wrist

pain free grip decreased due to pain to 18.5 Kg

palpation: P=5/10, II+, tender area was a bit wider

active wrist flexion was 30º-limited by pain (left side 45º)

active wrist extension was 70º-limited by pain (left side 80º)

ECRB resisted extension most painful (8/10)

forearm in neutral resting position (probably antalgic position). Pain with pronation/supination.

Clinical reasoning

Tenderness was broader due to post-surgical inflammation, a normal process of healing. At that moment there wasn't any active inflammation but George didn't elevate his arm much, so the area wasn't well drained. Increased fluid within tissues increases the pressure to the mechanoreceptors, decreases their threshold and they generate pain. Pain free grip was weaker due to pain inhibition. Probably pain inhibition and fear of exacerbation, didn't allow George to fully extend his elbow joint. That's why after two weeks he had a lack of 5 in extension range. Two were the most possible elements that restrict full extension; the flexors-pronators muscles or the anterior joint capsule or both. If muscles were responsible, wrist flexion would improve the elbow extension. Posterior impingement was excluded because there wasn't pain with restriction, only a pulling deep feeling on the anterior joint aspect.

Management:

physiological passive elbow extension, sustained, grade IV++ (P=3/10) plus ease off

APs in 45º elbow extension and end-range. The technique was pain free. It was applied 3 times, for 2 min sustained, grade IV++ plus ease of

gentle drainage right limb massage. Focused a bit more with myofascial techniques on

pronators/flexors group

ended with gentle stretches limited to P1

kinesiotaping: - “star” application over lateral epicondyle

- “inhibition” application along ECRB/ECRL

- “lymphatic” drainage application over the hall upper limb

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elbow extension improved to full range (no pain)

asterisks didn’t change

felt less pressure around elbow joint

Home management:

pain free muscle pumping techniques with the hand over head at least every 2 hrs. Movements patterns were elbow flexion-extension, forearm supination-pronation, wrist flexion-extension, radial/ulnar deviation and griping

extend elbow actively end then force with other hand to full extension to maintain the new gained ROM

end always with self-stretches on: pronators, elbow and wrist flexors-extensors limited to P1

I thought of providing George with a forearm brace. But no current evidence proves its efficacy in short or long-term recovery. The area was too tender to withstand the pressure of a brace. I would probably give this later with return to sport; mostly to provide a sense of security while playing golf. Next appointment was arranged for next week.

Week 3 (post-operative)

S/E: found the exercises really useful. The sense of pressure into his forearm had gone. Pain with daily activities like brushing his teeth had significantly decreased (from 6/10 at 1st week to 3/10 at present).

P/E:

forced elbow extension P=4/10 to last 10º of extension
pain free grip increased to 21Kg
palpation: P=5/10, II+, tenderness was only localized on the site of surgery
active wrist extension 75º-limited by pain (left side 80º)
ECRB resisted extension was painful (6/10)

Management:

myophascial release massage on wrist-finger flexors/pronators
MWM: showed significant improvement of grip strength during lateral glide. I applied: 10 max pain free grips with lateral glides in 90 of elbow flexion, for three times.

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Full ROM in forced elbow extension, a bit painful (4/10)
pain free grip increased to 23.5Kg
palpation: P=5/10, on grade III
full ROM active wrist extension, a bit painful (4/10)
resisted ECRB slightly decreased (5/10)

Home management:

I applied a spiral taping technique from the forearm up to the arm that mimic the lateral glides and lift the forearm into relative supinated position. The literature suggests that the excessive pulling of

the ECRB is basically associated with supinator insufficiency (Noteboom et al 1994, Haker 1993, Pienimaki et al 1996, Vicenzino 2003, Ekstrom 2002). Therefore, the taping in combination with a re-education program for the supinator muscle and education concerning daily activities would be the key stone to safe return into normal life.

In the last 20 min I explained to George the above mentioned. I showed him a re-education exercise for the supinator muscle. He had to sit on a chair with a pillow on his thighs. His forearm was resting in neutral pronation-supination position on the pillow. He had to hold a light object such as a pair of scissors. He then had to pronate his forearm, from his wrist mainly, by keeping the forearm right after the elbow joint in a relative neutral supination-pronation position. In that way eccentric control of pronation was facilitated. The taping also helped to achieve the task.

Daily:

general pain free griping and wrist flexion-extension (resisted) with lateral glides for warm-up and general conditioning

supinator facilitation technique, as many times as he could without loosing control. Progression of weigh through week (like a bigger stick to a small hammer etc)

end up always with stretches on: pronators, elbow and wrist flexors-extensors limited by P1

Advised him not to extend his elbow neither to fully pronate his forearm when trying to reach an object. He should first fire up the supinator muscle and control forearm pronation; especially with daily griping activities.

Week 4 (post-operative)

S/E: was feeling like being completely recovered.

P/E:

full forced elbow extension revealed minor pain (2/10)
pain free grip increased significantly to 24,1Kg
palpation: P=4/10, III+ localized on lateral epicondyle
full active wrist extension with minor discomfort at end range
resisted ECRB extension was still most painful (5/10)

George after the weekend was going to return to his work. General advice was as for week 3 specified to more specific working related activities. He still was discouraged to type on the computer or involved in any manual activity. I also gave him a tennis elbow brace. He should were this only at work and at home only when had to carry heavy objects.

Management:

general postural observations and corrections
lateral elbow glides with resisted pain free wrist flexion/extension (thera-bands)
flashing technique mimicking ULNT 2b to improve neural mobility
myophascial release massage over flexors-pronators
stretching
spiral taping

I also showed him how to tape his elbow him self.

Week 6 (post-operative)

S/E: didn't have any serious problems at work. Only specific tasks were a bit discomfort like driving a tight screw occasionally. He found the brace really helpful when currying shopping.

P/E:

full forced elbow extension was pain free
pain free grip increased significantly to 28,7Kg
palpation on lateral epicondyle revealed minor discomfort
full active wrist extension was pain free
resisted ECRB extension was still painful (3/10)
ULNTT 2b was symmetric with left side

Management:

re-assessment of pronation eccentric control. Progression to more functional tasks (typing, golf club, writing with pen, lifting objects)
assessment of golf technique (did not find faults)
myophascial release massage on flexors/pronators
stretching
flashing
spiral taping

I encouraged him to have a go with short to medium balls on the coming weekend. The instructions were before any game to do good stretches, tape him self, wear his brace, do a good warm up and facilitate supinator muscle. Next appointment was for the next month.

Week 10 (post-surgical)

S/E: didn't have any worrying complaints. He was still feeling some soreness on the lateral elbow after prolonged typing (more than 30 min). But that was only once a week. The same happened if he was trying to untie something really tight like a stacked bottle top, especially if he was forgetting to facilitate his supinator muscle.

He also attempted some long balls on golf with success and no pain! He was feeling 90% cured. His last disability index score was 10%.

At his final retrospective examination, George had painless forced elbow extension and his maximum pain free grip was almost equal to his left side (31Kg). Palpation over the lateral epicondyle; resisted wrist and finger extension were also painless. Finally, his most comparable sign, resisted ECRB extension, was also pain free. A letter to his doctor was conducted with these findings.

I reminded him that the key to long-term recovery was to continue doing his daily supinator muscles facilitation and self-stretching program. He was also taught a more dynamic home-exercise program first introduced with success in tennis elbow patients from Pienimaki et al (1996). This program consisted of resisted wrist movements with thera-bands, push-ups against the wall, twisting a towel into a roll from ends and others. General directions were given for how to reach and lift objects, when to pause typing, when and how to use his brace and what to do before and after a golf game.

On sixth month post-surgery, he informed me by telephone that we was still pain free and the

soreness episodes had decreased significantly to one every three weeks or less depending on his activities. He was very pleased with his overall

progression and ensured me that the exercises and my advices were of worth. I haven't heard from him since then. He was well educated for his initial pathology, that's why he would be able to manage his own small sureness episodes associated with occasional overloading.

Conclusions-Discussion

In this bibliography, it was concluded that lateral epicondylalgia is a multifactorial musculoskeletal disorder causing controversial opinions regarding management modalities due to its uncertain aetiology and pathophysiology. While there isgeneral agreement, that lateral elbow pain is a self-limitating disorder, the spontaneous recovery time is quite controversial, including an assumed time-frame of one to two years (Noteboom et al 1994, Whaley and Baker 2004). However in this case, it was proposed that lateral release surgery combined with an extensive self-management program based on motor control and strengthening exercises, stretching and correction of contributing factors such as working environment ergonomics, are well promising inerventions for a quick and efficient recovery in tennis elbow. This is also well supported from curent literature (Pienimaki et al 1996, Vicenzino 2003, Noteboom et al 1994). The only grey area in this case was the lateral release surgery. While long-term folllow-up studies disregard the effectiveness of surgery, George was back to work 4 weeks after the surgery and 90% symptom free on week six. Moreover, after a six month follow up, the condition had further improved (Oswestry Disability Index score 5%). It is hard to assume what would have happened without the surgery and we really dont know what the surgeon really did.

Unfortunatelly, good methodological quality studies usually compare the effectiveness of one

intervention with a control group or versus another intervention. From the other hand, case studies like the one presented, which commonly use a variaty of interventions and thus reflex more the daily clinical practice, have poor evidence value; this is because it is not possible to generalize

individual results for a whole population. More studies of good methodological quality are essential to propose a specific treatment approach for lateral elbow pain.

Appendix I

The Greenhalgh critical appraisal tool consists of five questions:

Question 1: Can you find an important clinical question which the review addressed?

Question 2: Was a thorough search done of the appropriate databases and were other potentially important sources explored?

Question 3: Was methodological quality assessed and the trials weighted accordingly?

Question 4: How sensitive are the results to the way the review has been done?

Question 5: Have the numerical results been interpreted with common sense and due regard to the broader aspects of the problem?

The modified form, which has been used in this review, has one more additional question:

Question 6: How useful were the results?

Every question has to be answered with a “yes” or “no”. A positive answer counts for one point whereas a negative answer counts for zero points. The final score is recorded out of 6 items.

Greenhalgh T (1997): How to read a paper: papers that summarise other papers (systematic reviews and meta-analyses). *BMJ* 315: 672-675

Appendix II

The PEDro critical appraisal tool consists of 11 questions:

1. eligibility criteria were specified

2. subjects were randomly allocated to groups (in crossover study, subjects were randomly allocated an order in which treatments were received)

3. allocation was concealed

4. the groups were similar at baseline regarding the most important prognostic factors

5. there was blinding of all subjects

6. there was blinding of all therapists who administered the therapy

7. there was blinding of all assessors who measured at least one key outcome

8. measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups

9. all subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by “intention to treat”

10. the results of between-group statistical comparisons are reported for at least one key outcome

11. the study provides both point measures and measurers of validity for at least one key outcome

Each question has to be answered with a “yes” or “no”. A positive answer counts for one point, whereas a negative for zero points. The first question is suggested from the authors not to be considered what scoring a study. Thus, the final score is recorded out of 10 items.

Verhagen AP et al (1998): The Delphi list: a criteria list for quality assessment of randomised clinical trials for conducting systematic reviews developed by Delphi consensus. *Journal of Clinical Epidemiology* 51(12): 1235-1241

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