

# Evidence of Conservative Treatment for Overuse Injuries

## Analysis of Systematic Reviews

Aki-Matti Alanen

Ville Suomalainen

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University of Jyväskylä

Department of Health Sciences

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## ABSTRACT

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### **Evidence of Conservative Treatment for Overuse Injuries. Analysis of Systematic Reviews.**

Alanen Aki-Matti, Suomalainen Ville

Department of Health Sciences, University of Jyväskylä.

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Supervisors Prof. Ari Heinonen and Prof. Urho Kujala University of Jyväskylä.

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Overuse injuries are common among top athletes and people who exercise regularly. Conservative, non-pharmacological methods are used widely to treat overuse injuries and there is a large body of literature, including multiple systematic reviews, evaluating different terms of treatment. This literature needs summarizing and critiquing. Objective of this study was to evaluate the effectiveness of different methods of conservative treatment on overuse injuries and to provide an analysis of systematic reviews.

Published systematic reviews were identified by searching Medline, PEDro, Cochrane and Sportdiscus databases from the year 1996 to July 2010. Reference lists of identified studies were also hand searched. The assessment of quality of the reviews was performed by two individual reviewers according to a specifically designed scale for systematic reviews (Assendelft et al 1995) and only high quality reviews were included into analysis. 47 good or high quality systematic reviews or meta-analyses were included after final assessment.

Based on the 47 good or high quality reviews included, no firm conclusions can be drawn on the effectiveness of conservative treatments. There is limited evidence for taping when combined with other modalities and for exercise therapy. There is also limited evidence that physical modalities are not effective with the exception for ESWT. For other interventions evidence is inconclusive because of reporting faults and heterogeneity of studies.

There seems to be limited evidence in favor of exercise therapy and taping combined with other interventions in the management of overuse injuries. There is dearth of good quality evidence for the management of overuse injuries. Well conducted RCT's are in need and developing new clinical assessment tools for diagnosing overuse injuries should be considered.

Key words: "overuse injury", "stress injury" and "cumulative trauma disorder", "stress fracture", "apophysitis", "periostitis", "patellofemoral syndrome(PFPS)", "synovitis", "capsulitis", "chronic compartment syndrome", "tendinosis", "tendinopathy", "tendinitis", "bursitis", "nerve entrapment syndrome"

## TIIVISTELMÄ

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### **Systemaattisiin katsauksiin perustuva konservatiivisten hoitomuotojen vaikuttavuuden arviointi rasitusvammojen hoidossa.**

Alanen Aki-Matti, Suomalainen Ville

Terveystieteen laitos, Jyväskylän Yliopisto.

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Ohjaajat Professori Ari Heinonen ja Professori Urho Kujala Jyväskylän Yliopisto.

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Rasitusvammat ovat yleisiä säännöllisesti liikuntaa harrastavien ihmisten ja huippu-urheilijoiden parissa. Rasitusvammojen hoidossa on käytössä useita konservatiivisia hoitumuotoja ja niitä on tutkittu laajasti kirjallisuudessa. Kirjallisuuden tuomien tulosten yhteenveto ja kriittinen arviointi on kuitenkin vajavaista ja tämän tutkimuksen tarkoituksena onkin arvioida laaja-alaisesti erilaisten konservatiivisten hoitomuotojen vaikuttavuutta ja tuottaa yleiskatsaus tuloksista.

Systemaattisten katsausten haku suoritettiin vuodesta 1996 vuoden 2010 kesäkuuhun Medline-, PEDro-, Cochrane- ja Sportdiscus-tietokannoista. Haun perusteella saatujen katsausten referenssilistat käytiin myös läpi. Systemaattisten katsausten laadun arviointi suoritettiin kahden arvostelijan voimin Assendelft et al (1995) kehittämän katsausten arviointikriteeristön pohjalta. Vain korkealuokkaisiksi arvioidut katsaukset otettiin mukaan analyysiin. Katsaukseen hyväksyttiin lopullisen arvioinnin jälkeen 47 systemaattista katsausta tai meta-analyysejä.

Katsaukseen hyväksytyjen hyvälaatuisten 47 systemaattisen katsauksen arvioinnin perusteella ei voida esittää selkeitä tuloksia eri konservatiivisten hoitomenetelmien vaikuttavuudesta. On rajoitettua näyttöä että teippauksen yhdistäminen muihin hoitomuotoihin ja harjoitusterapia ovat vaikuttavia. Lisäksi on rajoitettua näyttöä että fysikaaliset hoitomuodot ESWT:a (extra corporeal shockwave therapy) lukuun ottamatta eivät ole vaikuttavia. Muiden interventioiden osalta näyttö on epäselvää rasitusvammojen hoidossa, johtuen raportoinnin puutteista ja tutkimusten heterogeenisyydestä.

Tämän katsauksen tulosten perusteella aktiivinen lähestyminen rasitusvammojen hoitoon ja tarvittaessa teippauksen yhdistäminen hoitomenetelmiin on rajoitetun näytön valossa suositeltavaa. Rasitusvammojen hoidossa käytettävien interventioiden vaikuttavuuden varmistamiseksi tarvitaan enemmän hyvälaatuista tutkimusta. Huolellisesti toteutettuja RCT tutkimuksia tulisi tehdä enemmän ja kehityskohteeksi tulisi ottaa myös uusien yhtenäisten ja luotettavien kliinisten arviointimenetelmien kehittäminen rasitusvammojen luokitteluun.

**List of abbreviations**

CTS = Carpal Tunnel Syndrome

DTFM = Deep Friction Tissue Massage

ESWT = Extracorporeal Shockwave Therapy

ITBFS = Iliotibial Band Friction Syndrome

LET = Lateral Epicondylitis

PFPS = Patellofemoral Pain Syndrome

RCT = Randomized controlled trial

SIS = Shoulder Impingement Syndrome

TENS = Transcutaneous Electrical Neuro Stimulation

US = Ultrasound

## 1. INTRODUCTION

The connection between physical activity and health has been well documented. Physical activity is estimated to be one of the top three preventable causes for morbidity, mortality and disability in developed countries (5). The benefits of participating in sports include also mental health, community well-being and social capital. However, injuries or bad health have been documented as potential barriers in participating in sports (1).

About 50% of people who participate in sports are injured in some point of their lives. At least half of these injuries are related to overuse (2) (3). Sports injuries are in most cases connected to changes in the type of training, intensity and duration and they can accumulate before any symptoms occur. Intrinsic factors that can cause an injury are malalignment, muscular imbalance, muscle weakness, inflexibility and instability. Extrinsic factors include poor technique, improper equipment, and improper changes in duration and frequency of exercising (3).

Overuse injuries are very much related to the demands of each sport, depending on physical demands and the type of exercise. In literature, overuse injuries are classified many times on sport basis. For example endurance athletes have more risk of overuse injuries because of excessive loading and insufficient recovery. There are many different types of overuse injuries, based on anatomical location and tissue type. Typical overuse injuries are patellofemoral pain syndrome, iliotibial band friction, medial tibial stress syndrome, Achilles tendinopathy, plantar fasciitis and stress fractures in lower extremities (4). Overhead athletes suffer usually from overuse injuries of shoulder (5).

Overuse injuries are defined by repetitive stress on tissue with inadequate time of recovery. Term overuse injury can encompass a broad spectrum of different musculoskeletal disorders which are caused by micro-traumas (6).

The purpose of this study was to analyze different systematic reviews and meta-analysis concerning conservative treatment methods that are used for overuse injuries. Conservative, non-pharmacological methods are widely used all over the world to treat overuse injuries, but comprehensive evidence about effectiveness is missing. During last fifteen years there have been published multiple systematic reviews about different treatment methods. In this study we evaluated the effectiveness of different methods of conservative treatment on overuse injuries. After quality assessment, only good and reasonable quality reviews were accepted to provide analysis of effectiveness.



## 2. BACKGROUND OF OVERUSE INJURIES

Overuse injuries are most commonly found in 18-30 year old athletes and also in 30-40 year old recreational athletes (6). Factors increasing risk for overuse injuries can be intrinsic or extrinsic, including anatomical malalignment, muscle imbalance, improper technique or faulty equipment. Term overuse injury encompasses a wide variety of disorders that are caused by repetitive stress on tissues and inadequate time for recovery (6). Many of overuse injuries are named sport-specifically, for example runner's knee, tennis elbow or jumper's knee, but also considered affecting specific tissues, bone, muscle or tendon (6).

Treatment methods for overuse injuries vary widely depending on the site of injury and also the time of symptoms and severity. It has been found that conservative treatment was three times cheaper than surgery in patellofemoral pain syndrome(PFPS) and the results didn't favor surgical methods in any aspect (7). According to this, the use of conservative methods would be recommendable within healthcare system, because it is inexpensive and of course does not overload surgeons.

When considering athletes and especially top-level athletes, it is extremely important that recovery time is as short as possible and the outcome of treatment is long-lasting. For example in Olympic games in Athens 2004, 188 athletes used physiotherapy services, and in 55% of cases the reason was overuse injury. The average amount of physiotherapy visits was two, so treatment methods had to be effective, considering the duration of competitions (8).

## **2.1 Lateral Elbow Tendinopathy (LET)**

Lateral epicondylitis, also known more familiarly as tennis elbow, is a painful pathology of lateral epicondyle. Pain is usually connected to gripping and manipulation of the hand. It is very common condition, four to seven patients per 1000 in general practice and 1-3% of general population (9).

Although the condition is commonly referred to as tennis elbow, only 10% of the patient population are actually tennis players. Approximately 50% of tennis players have pain around lateral epicondyle and approximately 75% of these cases are tennis elbows (10).

Lateral epicondylitis was previously thought to be an inflammatory process that is caused by partial tear between extensor carpi radialis brevis tendon and the periosteum of the lateral epicondyle. Latest research has noted that inflammation is not likely to be the cause, but failed reparative process of tissue. Term lateral elbow tendinopathy is recommended because of the lack of inflammation. Response to different conservative and surgical treatment varies very much and shows that understanding of this disease process is still incomplete (11).

## **2.2 Exercise induced stress reactions and fractures of bone**

Stress fracture is the most common overuse injury affecting bone tissue. Early stage of stress fracture is bone strain which can be identified as radioisotope concentration on painless areas of bone tissue. This is early stage of bony remodeling, which can lead into stress fracture (12).

Osteitis and periosteitis are also counted among overuse injuries. Typical osteitis is found in pubic bone which is identified as deep pain and tenderness. Multiplied radioisotope concentration is found in bone imaging (13).

According to systematic review published by Verrall et al (14) conservative treatment seems to be promising in treating chronic groin injuries. However, this review included three studies of which none was a randomized controlled trial. There are no comparative studies between conservative treatment and surgery in treating groin injuries.

Spondylolysis is also accounted into bone overuse injuries. Spondylolysis is found more often in sports that include repetitive stress to lower back vertebrae, such as gymnastics and canoeing (15). In some instances spondylolysis is also called stress fracture of spine or gymnasts back (12). Findings of spondylolysis in sports vary and there is no exact knowledge that spondylolysis would be found more often in sports than normal population. In some sports it has been suggested that incidence is higher (16).

### **2.2.1 Stress fracture**

Stress fracture is partial or complete fracture of bone that is caused by repetitive stress, which alone would not be sufficient to cause a fracture. Stress fractures can occur in several different bones, but the most usual are tibial, femoral neck, III-IV metatarsal and spine stress fractures, which is also called spondylolysis. Runners are especially in risk of stress fractures and the most usual causes are sudden changes in duration, intensity or frequency of training. 0,7-20% of all injuries in sports are stress fractures (17-19).

Other causes for stress fractures found in studies are for example earlier stress fractures in the same area of injury and lowered bony mass. There are also

differences between men and women, for example irregular menstrual period increases the risk for stress fractures in young long distance runner females (20). Female athletes that suffer from eating disorders can have insufficient amount of nutrients needed in bony remodeling (21) and stress fractures have been found to diminish when supplementary calcium and vitamin D products are added to daily nutrition (22).

### **2.2.2 Spondylolysis**

Lower-back problems are common among athletes. According to several studies athletes could be at higher risk for low-back pain than age-matched controls. Pain in back is a common reason for lost playing time by competitive athletes and some sports have higher rate of severe low-back pain than others. In sports like rhythmic gymnastics, wrestling and rowing athletes' lower spine has to perform demanding and extreme tasks without problems (16).

In acute phase, conservative treatment is usually effective, but persistence of pain and progression of vertebral slipping or nerve originated pain occur are indications for operative treatment. Conservative treatment and the level of training are dependent on the level of instability, progression of vertebral slipping and clinical symptoms (23).

The usual cause for spondylolysis in sports is repetitive extension movement of the back, which requires broad range of motion. Activities demanding wide extension-flexion movement cause great stress on pars interarticularis and thus add up the risk for spondylolysis (24).

### **2.3 Patellofemoral pain syndrome (PFPS)**

PFPS is found to be difficult to define, because patients experience many different symptoms from the joint and the level of pain and physical impairment varies. That is the reason why there is also other terminology used, such as anterior knee pain, chondromalacia patella, patellar pain and patellofemoral arthralgia. The reason why term patellofemoral is used is that many times it is hard to say which part or specific structure of the patella or the femur is affected. Pain is always experienced, but other symptoms are found as well so the word syndrome gathers them all up (25). Proprioception is disturbed in patients with PFPS. That is why joint biomechanics, motor control, pain and proprioception need to be treated as co-dependents when evaluating and treating PFPS (26).

Patella taping and muscle strengthening programs are commonly used in treating PFPS. One specific treatment is the McConnell approach, which includes specific taping of patellofemoral joint with intention to correct abnormal patella alignment and exercises that aim in strengthening especially the vastus medialis oblique muscle (VMO). The combination of 4-week exercise program combined with taping has been shown to be more effective than placebo taping and exercise or exercise only (27). The PFPS Severity Scale was developed in the beginning of 21 century. It has been found a reliable and valid tool to estimate the severity of patellofemoral pain syndrome (28).

### **2.4 Overuse injuries of tendon**

Stress injuries of tendons are a common issue in sports and occupational health care. Half of the injuries in sports are caused by overuse (12). Most of the bigger tendons (achilles, patellar, rotator cuff and wrist extensor tendons) are prone to overuse injuries. Stress can lead to pathological changes in the tendon (29). For example the lifetime prevalence of Achilles tendinopathy among runners is estimated

to be 11% (12). Histological definitions such as tendinosis and tendinitis should be used only after verification of histopathological findings (30).

Tendinosis is the degeneration of the tendon without clinical or histological findings of inflammation in the tendon (31). It is unclear why tendinosis causes significant pain for some people while others experience no pain while the tendon might rupture (32). Tendinosis affects all the components of the tendon, the collagen, tenocytes and extracellular matrix. Part of the collagen fibers experience lysis, part loose uniform structure while fiber's cross sectional area decreases and general collagen density decreases. Microtrauma is possible and structure of collagen fibers becomes more irregular. Type III collagen is out of proportion and neovascularization changes tissues structure (33) (29). Therefore tendinosis is a combination of different histopathological changes (34).

Lately the term tendinopathy has been adopted to describe different kinds of tendon pain caused by overuse. Often tendinopathy is defined like tendinosis. Tendinopathy is associated with degeneration and disorganization of collagen fibers, increase in cell count and minimal inflammation. The tendon thickens, its mechanical properties decrease and it becomes painful. Because of the overuse metalloproteinase increase, cells of the tendon die and become replaced by cartilage like cells. Protecting factors like IGF-1 and NOS increase. Tendinopathy seems to develop because of the imbalance between disrupting and protecting factors. The result is tendon degeneration, weakness, ruptures and pain (35).

In tendinitis tendon should present inflammatory features. Clinically however tendinitis often refers to clinical syndrome rather than specific histopathological findings (34, 35). The overused tendons present very little or no inflammation at all. Moreover the traditional treatment modalities to control the inflammation have failed when treating chronic painful tendon caused by overuse (35).

## **2.5 Plantar fasciitis/fasciosis**

Plantar fasciosis has been reported as one of the most common disorders causing inferior heel pain and it is estimated that it affects 10% of the general population at some time during life. Recent histopathologic research has found no signs of inflammation in plantar fascia connected to overuse injury formerly called plantar fasciitis. In light of new information it is preferable to call this injury plantar fasciosis, because degenerative changes in the fascia are found. Synonyms for this injury are plantar fasciitis, plantar heel pain, heel spur and runners heel. The lack of consistent nomenclature and definition remains because there is so little definite information about this disorder. Development is thought to be multifactorial connected with both intrinsic and extrinsic factors. Most common symptom is pain localized to the medial tubercle of calcaneus, which is exarbatated after periods of non-weightbearing activity. For example first steps in the morning are usually very painful and after few minutes the pain decreases to be worsened again if time on the feet increases (36).

## **2.6 Iliotibial Band Friction Syndrome(ITBFS)**

Iliotibial band friction syndrome was first defined by Renne (37) as pain on the lateral side of the knee with with lower limb activities such as running and cycling. Incidence of ITBFS varies 1,6-52% depending on the population. With cyclists ITBFS causes 15-24% of overuse injuries and among army recruits 1-5,3% while within inactive population it is fairly uncommon (38).

Ethiological reasons for ITBFS are considered to be friction of the distal part of iliotibial band (ITB) on the lateral femoral epicondyle (LFE) with repeated flexion-extension movements of the knee. Repeated soft tissue irritation leads to unsuccessful recovery between training sessions. Pathological changes include inflammation and irritation of both lateral synovial structure and posterior part of ITB and inflammation of LFE periostium (38).

## **2.7 Carpal Tunnel Syndrome (CTS)**

Different kinds of peripheral nerve injuries specific to a sport are possible. These sports include most often american football, ice hockey, football, baseball and winter sports. Also with seemingly lighter sports such as golf and dance nerve injuries are reported. It is likely that the incidence of nerve injuries is underestimated within literature. Injuries can be caused by trauma, overuse or impingement (39).

Compression on the median nerve at the wrist is the cause for carpal tunnel syndrome. Symptoms are most usually pain (mild to severe), which can radiate to forearm and feelings of pins and needles on the hand affected. It is evaluated to affect one percent of the population, but it is found to be more likely in populations where repetitive wrist movement is needed, such as meat packers (40).

## **2.8 Subacromial Impingement Syndrome (SIS)**

Shoulder complaints are common musculoskeletal injuries. The prevalence varies from 6,7 to 66,7% in a year's follow-up depending on the population(41). Shoulder impingement syndrome (SIS) is a common disorder. The cumulative incidence for shoulder complaints on GP's appointment is 11,2/1000 patients within a year and 40% of these are SIS (42). Although shoulder pain is the second most common complaint after low back pain on GP's appointment the definition of SIS has been is vague. Often SIS is defined as inflammation or degeneration of subacromial tissues leading to pain and dysfunction (43). Impingement can be also divided into primary and secondary impingement (44, 45) .

Primary is a direct result of compression of the rotator cuff tendons between the humeral head and the overlying anterior third of the acromion, coracoacromial ligament, coracoid or acromial clavicular joint. Secondary impingement is caused by



underlying instability of the glenohumeral joint which can be structural or functional. Walch et al (46) have also described internal impingement where impingement is the shoulder in a position of 90° of abduction and 90° of external rotation causes the supraspinatus and infraspinatus tendons to rotate posteriorly and rub on the posterior-superior glenoid lip, and become pinched or compressed between the humeral head and the posterosuperior glenoid rim.

## **2.9 Groin pain**

The incidence of injury to the groin region represents 5–18% of reported athletic injuries (47) (47). Numerous conditions are reported in the literature as possible causes of acute or chronic groin pain in athletes (47, 48). If the presenting symptoms are aggravated by activity and relieved by rest, then symptom behaviour is suggestive of a musculoskeletal disorder. Structures likely to be involved include adductor and lower abdominal musculature, the pubic bone, and the pubic symphysis and its capsular tissues. There are controversial results concerning musculoskeletal risk factors (47).

## **2.10 Medial tibial stress syndrome and Compartment syndrome**

American Medical Association defined compartment syndrome as a pain in lower limb caused by repetitive activity on a hard surface in year 1966. Diagnosis relates to musculo- skeletal inflammation and excludes stress fractures and ischemic diseases. The pathophysiology of compartment syndrome is unclear but the aethiology might include bone changes, periostitis and pathological changes of muscle insertions (49). Terminologies of these conditions vary considerably in literature and clinical surroundings. Shin splints is very often used to describe MTSS but in some cases these different conditions are both described with this term, and that makes it very important to differentiate MTSS, compartment syndrome and stress fracture well in trials (50).

Medial tibial stress syndrome (MTSS) is a type of exercise-induced leg pain that is very common in recreational and competitive athletes. Recent studies have supported the view that MTSS is not an inflammatory process of the periosteum, but instead a stress reaction of bone that has become painful. MTSS is described as pain along the posteromedial border of tibia that occurs during exercise, excluding pain from ischaemic origin or signs of stress fracture. But no official definition exists, so the comparison of studies about MTSS is difficult. The diagnosis of tibial stress fracture and exertional compartment syndrome should be excluded (50)(51). Compartment syndrome causes 6-16% of runners' injuries. Among young competitive athletes compartment syndrome is the most common reason for lower limb pain. Compartment syndrome is relatively common with ballet dancers and army recruits (49).

### **3. DESCRIPTION OF CONSERVATIVE MANAGEMENT**

Conservative management covers all treatment methods except surgical treatments. Medical treatments and injections are also counted as conservative treatment but they are excluded in this overview (41). Conservative methods are widely used in treating various injuries in sports, including overuse injuries (52). Conservative treatment is used as a primary method in treatment and surgeries will be necessary when the outcome of conservative treatment has not been as successful (14).

Rehabilitation of an injured athlete can be divided into acute, recovery and functional phases. Most often used conservative methods are physical treatments, therapeutic exercise and functional sport-specific exercises which are many times combined (53).

#### **3.1 Exercise therapy**

Therapeutic exercise incorporates elements of postural control, motor control, motor learning and coordination covering stabilization, muscle performance, vestibular rehabilitation, functional movement training, relaxation exercise/ techniques, pain inhibition and edema control (47).

Term exercise therapy is used when considering pathologies or diseases which make the difference to for example hypertrophic muscle training or endurance training. The goal of exercise therapy is precisely to recover activity and functional capacities (54). After careful inspection of patient or client, exercise therapy is planned to meet the demands of disabilities of body. The goal of both short and long term exercise therapy is to enhance or improve range of motion, flexibility, muscle force, motor control and endurance, respiratory system, coordination, proprioceptics, agility, balance, functional capacities and stability (53).

In recovery phase of rehabilitation dynamic exercises are extremely important to improve force- open kinetic chain exercises are important in certain joints and also to combine concentric and eccentric work. Dynamic exercises can also be used to improve muscle force in certain muscles (55).

Various disorders are managed by exercise therapy. It can be explained by the prescription of muscular contraction and bodily movement to improve the overall function of the individual and to help meet the demands of everyday life (56). In treating achilles tendinopathy, exercise therapy has proven to be effective. The results are promising and exercise therapy is recommended as either primary treatment method or at least combined with other methods such as ultrasound, injections, surgery or hot and cold treatments (57).

Greatest muscle force is created by eccentric contraction. Eccentric exercises are to be used carefully because they also cause great stress on muscle tissue and muscle damage. Eccentric training has shown promising results on treating different kinds of tendinopathies (53). In treating patellar tendinopathy, eccentric exercises are mainly used as corner stones when planning exercise therapy. Painful eccentric exercises have been shown to be effective in treating Achilles tendinopathy (58). The study by Visnes et al (59) showed that the use of incline board, at least some level of pain combined with eccentric training are recommended. They evaluated seven different eccentric training protocols as conservative treatment to jumper's knee.

### **3.2 Manual therapy**

Manual therapy techniques consist of a broad group of passive interventions in which physical therapists use their hands to administer skilled movements designed to modulate pain; increase joint range of motion; reduce or eliminate soft tissue swelling; inflammation; or restriction; induce relaxation; improve contractile and noncontractile tissue extensibility; and improve pulmonary function (60). These interventions involve a variety of techniques, such as the application of graded forces (47).

These techniques include joint mobilization or manipulation, soft tissue mobilization or manipulation and mobilization of neural elements (61). Treatment may include moving joints in specific directions and at different speeds to regain movement, muscle stretching, passive movements of the affected body part, or having the patient move the body part against the therapist's resistance to improve muscle activation and timing. Selected specific soft tissue techniques may also be used to improve the mobility and function of tissue and muscles (47).

### **3.3 Orthotic devices and insoles**

Foot orthotic devices are used widely in various sports to prevent and treat injuries. Studies in military recruits and personnel have shown positive effects of orthotic devices in preventing overuse injuries (62). Foot orthoses have been shown to modify the biomechanics in gait, for example by decreasing internal rotation of tibia and thus improving the timing of subtalar joint motion in conjunction with tibial internal rotation, which may lead to overuse injury (63). Although there are positive results with military personnel, there are also studies that have not been able to find difference in the injury rates of athletes who did or did not use foot orthotics (64).

The motion of foot and ankle effects the power transition through lower limb kinetic chain during walking. It is important that lower limb can divide these different rotator, bending, twisting and pressure inducing forces evenly to avoid abnormal stress and tissue damage following to that (65). Typical injuries caused by abnormal mechanics treated with insoles are for example plantar fasciitis, shin splints and different pain conditions of knee (62).

Insoles have in many cases been reported effective, but this is many times based on subjective or empirical knowledge (55). One of the most important theories about the function of insoles is that insoles change sensomotorical or proprioceptive feedback to brain, when protective reactions through muscle-nerve function follow. This could be the reason why the effect of insoles varies so widely among users (66).

### **3.4 Physical treatment modalities**

Treatment modalities include cryotherapy, electrical treatments, biofeedback, hydrotherapy and mechanical treatments. Physical treatment modalities have been studied widely and some of them have been found to be ineffective according to earlier treatment recommendations and meta-analysis. Meta-analysis (54) about the effects of physical treatment modalities concluded that there are only few good quality studies and the quality varied greatly. Most of the studies reviewed, showed that the benefits of physical treatment modalities were miniscule and the difference to placebo treatment was not found. Some studies have shown effects on TENS, however ultrasound treatments have not shown any effects (54). Extracorporeal shockwave therapy (ESWT) has recently shown effectiveness in treating tendinopathies. For example in randomized controlled trial by Wang (67) the results for ESWT group were significantly better compared to control group which used NSAID's, physiotherapy and knee brace. However opposite findings are also available.

### **3.4.1 Ultrasound**

Therapeutic ultrasound is one of the most widely used forms of electrotherapy. Although this treatment option is used in many different conditions and well known over 60 years, its benefits and effects are still not known (68). Ultrasound is a form of mechanical stimulation, which is also used in treating fractures. It has been speculated that ultrasound helps healing fractures, because it creates low-level stress on bone tissue, which enhances bony remodeling (69).

In systematic review by Robertson et al (68) about the effectiveness of ultrasound therapy they found two RTCs concluding the effects of ultrasound therapy considerably better than in placebo group. These trials were mostly heterogeneous and dosage and intensity varied significantly. The clinical effectiveness of ultrasound is very small, although it is widely used in treating soft tissue injuries and relieving pain. The study by Griffin et al (69) showed positive effects of ultrasound in speeding up the healing process of fractures.

### **3.4.2 ESWT**

Extracorporeal shockwave therapy is a relatively easy and cost-efficient option, if it gives the hoped-for benefits. Shock waves used in treatment are single-impulse sound waves, which create fast rising in pressure. Waves can be produced electrohydraulically, electromagnetically or piezoelectrically. The amount of impulses and density of energy together specify total energy used in treatment. Treatment options differentiate low energy and high energy modes (70).

In recent years ESWT has been used in treating plantar fasciitis, lateral epicondylitis, rotator cuff tendinitis and in treatment of certain stress fractures. Treatment method is

based on fragmentation of calcification created by shock waves and pressure impulses and also pain relieving effects (71).

### **3.4.3 Laser**

Low level laser therapy has been used over three decades, but the conclusions about effectiveness are inconclusive (72). The use of lasertherapy is based on thought that laser radiation, which is itself too low powered to produce tissue warming, creates clinically significant results in treatment of soft tissue injuries and neuropathies. The mechanisms of laser therapy are inconclusive and only partly understood. What is known, is that cell function changes in addition with small amount of warming (temperature change  $\leq 0,5^{\circ}\text{C}$ ) and the intensity of laser therapy is 10-100 times smaller than for example ultrasound or shortwave treatments (73).

## **3.5 Other forms of conservative treatment**

There are multiple methods of conservative treatments used with conservative injuries, but we are introducing only those that are used in reviews that are included in this systematic review. For example LPG-treatment and kinesiotaping are used in physical therapy but systematic reviews about these treatment methods were not found.

### **3.5.1 Taping**

Taping has been used as a treatment method for multiple overuse injuries. Research has shown that ankle joint taping is the most efficient way to prevent injuries in subjects with history of ankle injuries (74). Taping is considered to be a short-term



intervention owing to possible adverse events such as skin irritation. In many studies taping construction has been applied for one week maximum but in some cases also longer periods are used (36). There are a variety of taping methods and techniques and also tape materials can vary widely, which makes it very important to report precisely which taping technique and tape material has been used, when evaluating the effects of therapeutic taping. Australian physiotherapist Jenny McConnell developed a patellar taping technique in the 1980's which is still used widely in treating PFPS (75). This McConnell technique aims to correct the patellar tracking and position which decreases pain. This taping was showed very effective with 92% success rate in rehabilitation (47). Therapeutic kinesio taping was developed by Japanese chiropractor Kenzo Kase in 1973. He developed an elastic tape material that could be used for days and would lift the skin to facilitate the superficial lymphatic pathways, improve circulation, support muscles and joints while promoting healing (76).

### **3.5.2 Recovery from training**

Recovery from training is used as primary treatment method in sports injuries. Nash et al (77) concluded in their systematic review that early mobilization of injured limbs was even better or at least as good treatment method as rest.

#### **4. SUMMARY OF LITERATURE**

Systematic analysis of summarized results effectiveness on conservative treatment on different overuse injuries are lacking. Barton et al (78) published a systematic review of the scope and quality of systematic reviews on nonpharmacological conservative treatment for patellofemoral pain syndrome (PFPS). Their conclusion was that systematic reviews need to be conducted with more rigorous methodological design and that there are no up-to-date high-quality systematic reviews about conservative treatment for PFPS.

Similar information about other overuse injuries is needed as well as updating previous results, because there are several systematic reviews published during last two years. To optimize patient outcomes for complex conditions of overuse injuries it is essential that physical therapists can be provided with guidelines of treatment that are based on best available level of evidence.

## 5. OBJECTIVES

The aim of this analysis of systematic reviews was to examine the effectiveness of conservative treatment on overuse injuries.

More detailed research questions were as follows:

- 1) Are conservative treatments effective for overuse injuries?
- 2) What is the average methodological level of systematic reviews on conservative treatment of overuse injuries?

## 6. METHODS

### 6.1 Search methods

MedLine, Cochrane, PeDRo, SportDiscus databases were searched for the period January 1995 until July 2010. We also screened the reference lists of included reviews. Systematic reviews published before 1995 were not included.

The following keywords were used in databases search tools: acupuncture, apophysitis, band, brace, bursitis, capsulitis, chronic, chronic compartment syndrome, compartment, concentric, conservative, conservative treatment, cryotherapy, cumulative, cumulative trauma disorder, disorder, eccentric, elbow, electric, electric stimulation, electrotherapy, entrapment, epicondylitis, exercise, fasciitis, fractur\*, friction, hydrotherapy, iliotibial, iliotibial band friction syndrome, impingement, impingement syndrome, injur\*, joint, joint mobilization, knee, lateral, lateral epicondylitis, manipulation, manual, manual therapy, massage, mobilization, myofascial, myofascial release, nerve, nerve entrapment, orthotics, overuse, overuse injur\*, pain, patellofemoral, patellofemoral pain syndrome, periostitis, physical, physical therapy, physiotherapy, plantar, plantar fasciitis, rehabilitation, release, runners, runners knee, splint, spondylolisthesis, spondylolysis, stimulation, stress, stress fractur\*, stress injur\*, syndrome, synovitis, tape, taping, tendinitis, tendinopathy, tendinosis, tennis, tennis elbow, therapeutic, therapeutic exercise, therapy, trauma, treatment, ultrasound, ultrasound therapy.

Two reviewers (AA & VS) independently assessed the relevance of all references based on abstract. Full texts of all relevant reviews were read and the methodological quality was assessed by both reviewers. The reviewers were not blinded.

## **6.2 Inclusion criteria**

Systematic reviews or meta-analysis published in English or Finnish with a well documented search strategy that could be reproducible were included. Non-English and non-systematic reviews were excluded. The inclusion criteria required that studies discussed overuse injuries common with athletes and treatment method was conservative and non-pharmacological. Surgical treatment methods and pharmacological methods were excluded.

In this study overuse injury is defined as a condition where exercise loading causes pain without any noticeable external cause of injury. Overuse injury will gradually cause more pain during or after exercise and will eventually become worse. If not treated overuse injury can lead to a complete stop in exercising (79).

For this overview we considered pain and function as the primary outcomes. Other outcomes were also considered if they were adequately reported.

## **6.3 Data extraction**

One author (A-MA or VS) independently extracted data from each included review and the data was discussed with the other author. Instruments and scales used for assessment of methodological quality of the RCTs in the reviews (PeDro, Delphi e.g.) were extracted and entered into the table of characteristics of included reviews. Results for each comparison and outcome were extracted and pooled effect sizes with confidence intervals if possible. If no quantitative pooling was available author's conclusions were reported. Inconsistent results on the same intervention were analyzed for differences in methodological quality of the included RCTs.

## 6.4 Data collection and analysis

Electronic search yielded 5131 results. 4473 were excluded after evaluation of title and 603 after evaluation of abstract. Search was updated in august 2010 and the final number of systematic reviews entering evaluation was 69. Full articles were retrieved for evaluation and 22 of them were excluded after evaluation of papers leaving 49 articles for the review. Flow chart is shown in Figure 1.

Overall agreement between the two investigators (A-MA, VS) regarding quality assessment of the systematic reviews was initially acceptable, Pearson's correlation being 0,88 between reviewers. Most of the disagreements were caused by differences in interpretation when discussing the quality of scales used in evaluating randomized controlled trials (RCT) in systematic reviews. All disagreements were solved in consensus between reviewers. The agreement percents and Cohen's  $\kappa$  coefficients per evaluation criteria are shown in table 1.



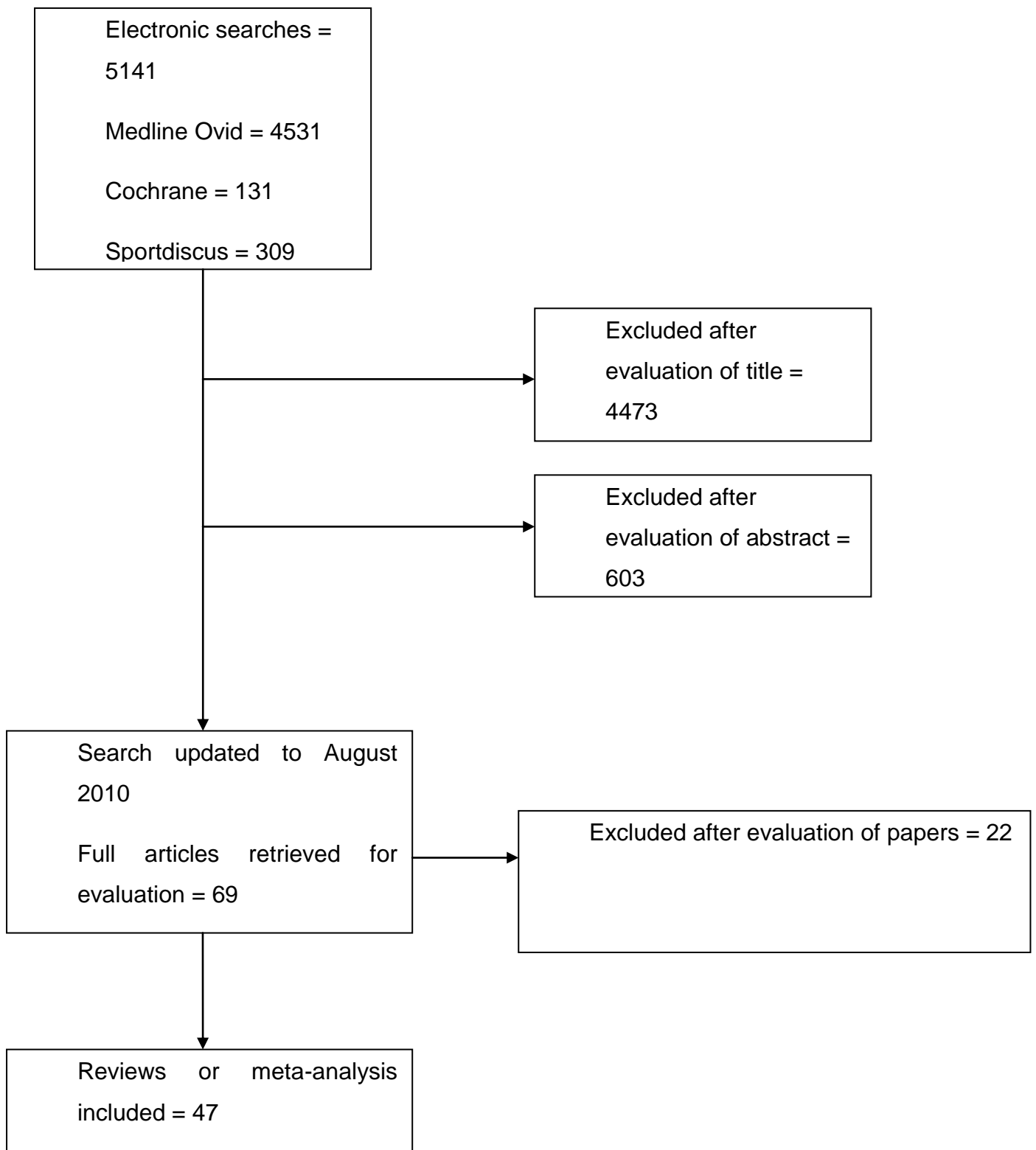


Figure 1. Flowchart of electronic search



## 6.5 Quality of reviews

The quality assessment was conducted using the criteria developed by Assendelft et al. (80). The list of criteria evaluates the following: The selection of studies (30points), assessment of the methodological quality of randomised controlled trials (20 points), description of the interventions (15points), data presentation (20points), and evaluation (15points) (see Appendix I). According to the points scored from evaluation criteria, systematic reviews can be divided in to five different categories which define the quality (72):

- Good quality (80 points)
- Reasonable quality (60-79)
- Moderate quality (40-59)
- Poor quality (20-39)
- Very poor quality (<20)

Two reviewers (A-MA and VS) participated in the selection and assessment of the quality of the systematic reviews. All included reviews were assessed by both reviewers and agreement percentage was calculated for each review and also Pearson's correlation and Cohen's  $\kappa$  for all analyzed reviews.

Natural choice for parameter when evaluating agreement in classification is percentage. This can be compared to how much of this classification is based on chance.  $\kappa$ -coefficient is based on this comparison and its value is greater, the more agreement on classification there is compared to chance. (81)

The evaluation methods for agreement were consulted from a statistician. Disagreements were discussed and resolved in a consensus meeting. If consensus could not be reached a third reviewer (AH) made the final decision.

The results of the quality assessment for each of the 54 identified eligible review articles are presented in appendix II. The methodological quality of the review articles was varying from poor to very good. Average score of included reviews was 69 (SD 9).

## **7. RESULTS**

Treatment methods are divided in seven categories: taping, exercise therapy, physiotherapy, physical therapy modalities, splinting/braces, manual therapy and acupuncture.

Main problem with evaluation of these methods was heterogeneity and flaws in reporting. For example term manual therapy includes multiple techniques and methods which are used widely and in many times reported very poorly.

## **8. EFFECT OF INTERVENTIONS**

### **8.1 Taping**

We located 4 systematic reviews covering the effectiveness of taping. The quality scores ranged from 62 to 74 points (Table 3). The quality of the studies evaluated by Pedro and Bizzini scales are shown in table 3.

The review by Aminaka et al. (82) investigated effects of therapeutic taping on PFPS. They used the PEDro scale to evaluate the methodological quality of included RCTs. Conclusion of their review was that patellar taping may provide a useful tool to clinicians in treating PFPS and that taping does not seem to exacerbate the symptoms.

The review by Bizzini et al. (83) investigated treatments reducing pain in patients with PFPS. One of their objectives was to develop a grading scale to judge the quality of clinical trials to allow efficient synthesis and dissemination of literature. They used a

scale they also had pilot tested to evaluate quality of RCTs included. Their conclusion was that combination of exercises with patellar taping and biofeedback was effective.

Warden et al. (84) investigated the effectiveness of taping and bracing on PFPS. They also used the PEDro scale to evaluate methodological quality. Same RCTs were found in this review as the previous ones. Conclusion was that tape applied to exert a medially-directed force on the patella produces a clinically meaningful change in chronic knee pain.

In the review by van de Water et al. (36) the effect of taping was evaluated. Statistical pooling was not possible due to heterogeneity in the studies. According to best evidence synthesis there is limited evidence in regard to pain improvement when comparing taping to placebo or to no treatment. No differences were found in function or in foot-health status. When comparing taping and stretching to stretching alone, there is indicative findings in favor of combined treatment for pain reduction and patient satisfaction according to one high quality RCT.

Table 3. Effectiveness of taping

Systematic review (total number of studies)	Score	Type of conservative treatment	No RCTs'			Quality RCT (range/max)			Conclusions SR			Dissent	Conclusions Panel		
			A	B	C	A	B	C	A	B	C		A	B	C
<b>PFPS</b>															
<i>Aminaka et al. 2005</i>	62	<i>Therapeutic taping</i>	12	4		3-5/10	4-9/10		+	+		<i>Differences in taping techniques and measurements</i>	+/-	+	
<i>Bizzini et al. 2003</i>	64	<i>Patellar taping -combined with exercise</i>	2			60-65/100			+				+		
<i>Warden et al. 2008</i>	70	<i>Patellar taping</i>	1	10		4/11	3-8/11		+	++		<i>Low quality studies, co-interventions?</i>	+	++	
<i>TOTAL</i>													+	+	
<b>Plantar fasciosis</b>															
<i>van de Water et al. 2010</i>	74	<i>-Taping</i>	2	3		5-9/10	2-5/10		+	+			+	+/-	
<i>TOTAL</i>													+	+/-	

A = Conservative treatment vs. no treatment, a placebo or a wait- and-see policy.

B = Conservative treatment vs. another treatment.

C= Comparing was not defined

Dissent = Disagreement between the conclusions in the systematic review and the conclusion of panel.

Ind = Insufficient evidence to support the effectiveness of conservative treatment defined, but there are indications to support the effectiveness

NA = not applicable (was not investigated in the review).

RCT = randomised controlled trial

SR = Systematic review

++ = Conservative treatment defined is effective compared to no treatments or other treatments

+ = Limited evidence compared to no treatments or other treatments

- = Conservative treatment defined is not effective compared to no treatment or other treatments

± = Conservative treatment defined is equally effective compared to no treatment or other treatments

? = Insufficient evidence to support or refute the effectiveness of conservative treatment defined

E= Exclusion from study, reason

PFPS = patellofemoral pain syndrome

In conclusion, taping is effective when treating patients with PFPS compared to no treatment or placebo and when combined with other methods taping is effective compared to other treatment methods without taping. Many of the studies show short-term effects only and also the avoidance of co-interventions is not reported or conducted properly. Some of these studies also had methodological flaws. In treating plantar fasciosis taping is effective compared to no treatment or placebo and other treatment methods.

## **8.2 Exercise therapy**

We located 13 systematic reviews covering the effectiveness of taping. The quality scores ranged from 63 to 85 points (Table 4). The quality of the studies included in the reviews evaluated by Cochrane, Bizzini, Delphi, Pedro, Sackett and van Tulder scales are shown in table 4.

Bisset et al. (85) conducted a comprehensive systematic review. 29 studies were included and they were assessed for quality using PEDro scale. The group found only one high quality RCT covering exercise alone. It was found that exercise reduced pain (SMD .97 95% CI 0.30-1.63) but not grip strength (SMD 0.66 95% CI 0.01-1.31).

Woodley et al. (86) evaluated the effectiveness of eccentric exercise on chronic tendinopathy. They used the PEDro scale and van Tulder scale to assess the methodological quality of RCTs (Table 4). The results of PEDro scale are shown in the following table. They could not make strong conclusions about effectiveness of eccentric exercises (EE) in treating tendinopathy. A limited level of evidence exists suggesting that EE reduces pain in patellar tendinopathy at 12-week stage compared to concentric exercise (CE). Limited evidence favors the use of EE in treating lateral elbow tendinopathy (LET) compared to ultrasound. Patient satisfaction and return to sport were more positive for EE so moderate evidence suggests the use of EE

compared to CE and in cases of LET compared to ultrasound. The systematic review of Bisset et al (82) had similar conclusions in their systematic review about different methods of conservative treatment in LET.

Desmeules et al. (43) evaluated the effectiveness of therapeutic exercise and orthopedic manual therapy for the treatment of impingement syndrome. They used Cochrane Musculoskeletal Injuries Group quality assessment scale to evaluate the methodological quality of seven RCT's included in their study (Table 4). Their conclusion was that there was limited evidence to support the efficacy of therapeutic exercise and manual treatment in treating impingement syndrome.

Exercise therapy was studied by Kelly et al. (87). They found limited evidence to support the use of exercise therapy in the treatment of subacromial impingement syndrome. They identified eight good-enough quality studies to their review, quality ranging from three to eight.

Michener et al. studied the effectiveness of different treatment methods on subacromial impingement syndrome (SIS). Their conclusion was that there is limited evidence in support of exercise. They evaluated the methodological quality of RCTs with quality list according to Sackett's guidelines, which includes 23 items and accounts for total of 69 possible points.

Faber et al. (42) reviewed the literature regarding treatment of impingement syndrome on functional outcomes. They included 13 RCTs which were assessed for quality using a list combining the criteria of the lists of Jadad et al and Verhagen et al. Of the included studies 6 were of high quality. They concluded that there is moderate evidence that exercise combined with manual therapy is more effective than exercise alone. For other interventions there is only limited evidence.



Trampas et al. (54) identified 5 RCTs (one low, two moderate and two high quality) assessing the effectiveness of manual and exercise therapy in the treatment of shoulder impingement. 4 of the RCTs were published after Faber's review (43). Methodological flaws preclude strong conclusions but it appeared that combination of manual and exercise therapy may be more effective than other interventions especially in short term. There is moderate evidence that supports the use of therapeutic exercises alone and limited evidence supporting the use of both manual and exercise therapy in combination.

The review by Bizzini et al. (83) investigated treatments reducing pain in patients with PFPS. They used a scale they also had pilot tested to evaluate quality of RCTs included. Their conclusion was that quadriceps strengthening was effective by having patients who receiving exercise programs were discharged earlier from physical therapy.

Heintjes et al. (88) investigated the efficacy of exercise therapy on PFPS. They used the criteria list recommended by Cochrane Bone, Joint and Muscle Trauma Group combined with the Delphi list to evaluate the methodological quality. Conclusion was that there is limited evidence that exercise therapy is more effective than no exercise in treating PFPS. Also there is strong evidence that open and closed kinematic chain exercises are equally effective, which was the conclusion of Fagan et al (89) also. Same RCTs were included in Bizzinis review.

Meyer et al. (90) wanted to determine whether an optimum dose of eccentric exercises could be recommended for treating chronic non-insertional Achilles tendinopathy. They evaluated RCTs with PEDro scale and included only high-quality studies with score no lower than six. Their conclusion was that there is no definite evidence on the efficacy of various dosages of eccentric exercises.

Wasiliewski et al. (91) evaluated the effectiveness of eccentric exercise to treat lower extremity tendinoses. They used the PEDro scale to evaluate the methodological quality of RCTs. Their conclusion was that there is no clear evidence that eccentric exercise protocols are more effective forms in treating lower extremity tendinoses than other forms of therapeutic exercise.

Kingma et al. (92) evaluated the effectiveness of eccentric overload training in patients with chronic achilles tendinopathy. They used the Delphi list for quality assessment. Their conclusion was that the effects are promising but no definite conclusions can be drawn. Trials lacked methodological quality. They evaluated four RCTs and five clinical trials which are not shown in the following table, but did not have effect to results to one way or another.

Woodley et al. (86) wanted to evaluate the effectiveness of eccentric exercise on chronic tendinopathy. They used the PEDro scale and van Tulder scale to assess the methodological quality of RCTs. The results of PEDro scale are shown in the following table. They could not make strong conclusions about effectiveness of eccentric exercises (EE) in treating tendinopathy. A limited level of evidence exists suggesting that EE reduces pain in patellar tendinopathy at 12-week stage compared to concentric exercise (CE). Limited evidence favors the use of EE in treating lateral elbow tendinopathy (LET) compared to ultrasound. Patient satisfaction and return to sport were more positive for EE so moderate evidence suggests the use of EE compared to CE and in cases of LET compared to ultrasound. The systematic review of Bisset et al had similar conclusions in their systematic review about different methods of conservative treatment in LET.

In the review by Piazzini et al. (93) 18 RCTs were included and they were methodologically assessed according to the Cochrane Back Review Group. They concluded that exercise therapy is not effective.

In the systematic review by Machotka (54) only one RCT was located. This high quality study supports the common clinical practice of exercise therapy as a main component of rehabilitation for groin pain in athletes.

Jansen et al. (94) included the same RCT in their review and concluded that there is level I evidence that physical therapy aiming at strengthening and coordinating the muscles stabilizing hip and pelvis has superior results compared with passive physical therapy.

Table 4. Effectiveness of exercise therapy

Systematic review (total number of studies)	Score	Type of conservative treatment	No RCTs'			Quality RCT (range/max)			Conclusions SR			Dissent	Conclusions Panel		
			A	B	C	A	B	C	A	B	C		A	B	C
LET															
				1			8/15			+					
<i>Bisset et al. 2005</i>	75	-Exercise		1			8/15			+					+
<i>Nimgade et al. 2005</i>	63	-Physiotherapy Including Exercise	1			9/11			++			Only 1 RCT	+		
<i>Woodley et al. 2007</i>	81	-Eccentric Exercise		3		5-8/10				+				+	
<i>Total</i>													+	+	
Shoulder+SIS															
<i>Desmeules et al. 2003</i>	65	Therapeutic exercise	1	3		12/24	12-16		+	+		Low methodological quality of studies	+	?	
<i>Kelly et al. 2010</i>	75	Exercise therapy	2	6		6-8/11	3-7		+	+/-			+	+/-	
<i>Michener et al. 2004</i>	67	-Exercise	1	4		41/69	34-41		++	+		Quality of studies, heterogeneity	+	+	
<i>Faber et al. 2006</i>	67	-Exercise -Exercise w/ Manual	2	1 1		4-5/11	6 6		+	+		Cuff repair studies included	+	+	+

		<i>Therapy -Postop Exercise</i>		4		8	3-5			+			?		
<i>Trampas et al. 2006</i>	65	<i>-Exercise</i>		4			6-9/11			+				+	
<i>Total</i>													?	?	
<b>PFPS</b>															
<i>Bizzini et al. 2003</i>	64	<i>Strength training</i>		2			65-85/100			+/-				+/-	
<i>Heintjes et al. 2003</i>	78	<i>Exercise therapy</i>	5	3	4	11-24/32	17-23/32	14-23/32	-	+	?	<i>Not many high quality studies, possible Hawthorne's effect</i>	-	+	?
<i>Total</i>													?	+	?
<b>TENDON</b>															
<i>Wasiliewski et al. 2007</i>	68	<i>Eccentric exercise</i>	1	10		7/11	4-8/11		-	+/-		<i>only one study on volleyball players</i>	-/?	+/-	
<i>Kingma et al. 2006</i>	60	<i>Eccentric overload training</i>		4			4-6/9			+/-		<i>Small groups, methodological flaws</i>		?	
<i>Woodley et al. 2007</i>	85	<i>Eccentric exercise</i>	1	10		7/10	5-8/10		+	+			+	+	
<i>Total</i>													+	+	
<b>CTS</b>															

<i>Piazzini et al. 2007</i>	61	-Exercise Therapy	1	5		8	4-6/11		+/-	+/-			+/-	+/-	
<i>Total</i>													+/-	+/-	
<b>GROIN PAIN</b>															
<i>Machotka et al. 2009</i>	64	-Active training		1			10/12			+				+	
<i>Jansen et al. 2008</i>	66	-Active training		1			7/9			+				+	
<i>Total</i>														+	

A = Conservative treatment vs. no treatment, a placebo or a wait- and-see policy.

B = Conservative treatment vs. another treatment.

C= Comparing was not defined

Dissent = Disagreement between the conclusions in the systematic review and the conclusion of panel.

Ind = Insufficient evidence to support the effectiveness of conservative treatment defined, but there are indications to support the effectiveness

NA = Not applicable (was not investigated in the review).

RCT = Randomized controlled trial

SR = Systematic review

++ = Conservative treatment defined is effective compared to no treatments or other treatments

+ = Limited evidence compared to no treatments or other treatments

- = Conservative treatment defined is not effective compared to no treatment or other treatments

± = Conservative treatment defined is equally effective compared to no treatment or other treatments

? = Insufficient evidence to support or refute the effectiveness of conservative treatment defined

E= Exclusion from study, reason

LET = Lateral Elbow Tendinopathy

SIS = Subacromial Impingement Syndrome

PFPS = Patellofemoral Pain Syndrome

CTS = Carpal Tunnel Syndrome

In summary exercise therapy is effective in patients with LET compared to no treatment or placebo and other treatment methods. Although there are not many studies covering this area and they range from low quality to high quality.

In treating overuse injuries of shoulder there is insufficient evidence to support or refute the effectiveness of exercise therapy. Studies are low quality and heterogenic. In treating PFPS exercise therapy is effective compared to other treatment methods but when compared to no treatment or placebo the evidence is insufficient. Many studies are of low-quality and reporting of interventions and possible co-interventions is poor. In treating overuse injuries of tendon eccentric exercises are effective in comparison with other treatment methods but when compared to no treatment it seems to be equally effective. Problems in these studies are small treatment groups. In treating CTS exercise therapy is equally effective compared to other treatment methods or no treatment. In treating groin pain exercise therapy is effective compared to other treatment methods.

### **8.3 Physiotherapy**

We located 4 systematic reviews covering the effectiveness of physiotherapy. The quality scores ranged from 63 to 81 points (Table 5). The quality of the studies evaluated according to Pedro and van Tulder scales are shown in table 5.

Barr et al. (95) evaluated the effectiveness of corticosteroid injections with physiotherapeutic interventions for lateral epicondylitis and findings indicated that corticosteroid injections are effective at short term and physiotherapeutic interventions are effective at intermediate and long term follow up. Due to limitations in methodological quality these findings should be interpreted with caution.



Bisset et al. (85) conducted a comprehensive systematic review. 29 studies were included and they were assessed for quality using PEDro scale. There was insufficient evidence to either support or refute the use of US as a unimodal treatment for LET when comparing with active treatments or placebo. There was also found that a marginal advantage existed over long term in using a combined physical intervention approach of deep friction massage, US and exercise when comparing with corticosteroid injection but not with wait and see policy.

Initial results in the systematic review by Herd et al. (96) on the effectiveness of manipulative therapy support the use of Mulligan's mobilization with movement in providing immediate, short and long term benefits. In addition positive results were demonstrated with manipulative therapy directed at the cervical spine.

Nimgade et al. (54) concluded that in the short term steroid injections and physiotherapy outperformed rest. Physiotherapy appeared efficacious regardless of time frame but not better than rest after three months.

Kromer et al. (97) wanted to summarize the effectiveness of physiotherapy on SIS. They included a total of sixteen studies which were evaluated with the PEDro scale. Their conclusion was that physiotherapy is equally effective combined with surgery or not in treating patients with SIS. They did not find any evidence supporting the use of ultrasound or laser, and exercise therapy seemed to be equally effective at home and supervised. Manual treatment combined with exercise had moderate evidence in support.

Table 5. Effectiveness of Physiotherapy

Systematic review (total number of studies)	Score	Type of conservative treatment	No RCTs'			Quality RCT (range/max)			Conclusions SR			Dissent	Conclusions Panel		
			A	B	C	A	B	C	A	B	C		A	B	C
<b>LET</b>															
<i>Barr et al. 2009</i>	80	<i>Physiotherapy vs. Injection</i>	5			4-8/11			+			<i>Short term effect for injection</i>	+		
<i>Bisset et al. 2005</i>	75	<i>Combined physical interventions</i>	1	1		13/15	11		+/-	+			+/-	+	
<i>Herd et al. 2008</i>	63	<i>Physiotherapy Other manipulative techniques</i>		3		5-7/10				+/-				+/-	
<i>Nimgade et al. 2005</i>	63	<i>-Physiotherapy Including exercise</i>	1			9/11			++				+		
<i>Total</i>													+	+/-	
<b>SHOULDER/SIS</b>															
<i>Kromer et al. 2009</i>	81	<i>Physiotherapy</i>	5	4		6-9/10	5-8		+/-	+/-			+/-	+/-	
		<i>-home exercise</i>	1			6			+				+		
		<i>-ultrasound</i>	1			8			-				-		
		<i>-home exercise</i>		3			5-6			-				-	
		<i>-laser</i>		2			8-9			?				?	
<i>Total</i>													?	?	

A = Conservative treatment vs. no treatment, a placebo or a wait- and-see policy.

B = Conservative treatment vs. another treatment.

C= Comparing was not defined

Dissent = Disagreement between the conclusions in the systematic review and the conclusion of panel.

Ind = Insufficient evidence to support the effectiveness of conservative treatment defined, but there are indications to support the effectiveness

NA = Not applicable (was not investigated in the review).

RCT = Randomized controlled trial

SR= Sytematic review

++ = Conservative treatment defined is effective compared to no treatments or other treatments

+ = Limited evidence compared to no treatments or other treatments

- = Conservative treatment defined is not effective compared to no treatment or other treatments

± = Conservative treatment defined is equally effective compared to no treatment or other treatments

? = Insufficient evidence to support or refute the effectiveness of conservative treatment defined

E= Exclusion from study, reason

LET = Lateral Elbow Tendinopathy

SIS = Shoulder Impingement Syndrome

In summary physiotherapy is effective with limited evidence when treating patients with LET when it includes exercises when compared to no treatment. Other physiotherapy methods, which are many times poorly reported, are equally effective when compared to no treatment or placebo. Combined physiotherapy interventions are effective when compared to other treatment methods. Problems are found in reporting of treatment methods and treatment intensity.

In treating SIS effectiveness of physiotherapy is insufficient when compared to no treatment, placebo or other treatment methods. In treating PFPS the effectiveness of physiotherapy is inconclusive. Only clear effects are seen in muscular imbalance, where physiotherapy has a positive effect.

#### **8.4 Physical Therapy Modalities**

We located 18 systematic reviews covering the effectiveness of physiotherapy. The quality scores ranged from 60 to 85 points (Table 6). The quality of the studies evaluated according to Bizzini, Cochrane, Delphi, Jadad, McDermid, Pedro, and van Tulder scales are shown in table 6.

Bisset et al. (85) conducted a comprehensive systematic review. 29 studies were included and they were assessed for quality using PEDro scale. No pooling was performed on studies covering acupuncture due to differences in the applied interventions and timing of outcome assessment but there appears to be some evidence to support the efficacy over placebo in short term and no difference between US and acupuncture. Pooling of data for laser treatment was possible and showed a null summated treatment effect on pain (SMD 0.33: 95% CI -.21-0.86), pain free grip strength (SMD 0.17: 95% CI -0.41-0.75) and global improvement (RR 1.09: 95% CI 0.77-1.53) at three months follow up. On long term follow up there was no evidence of an effect in laser over placebo on global improvement (RR 1.52: 95% CI 0.97-2.98) and grip strength (SMD -0.05: 95% CI -0.55-0.45). Data pooled from

two RCTs on efficacy of ESWT showed no significant treatment effect on pain (SMD 0.02: 95% CI -0.19-0.24) or global improvement (RR 1.01: 95% CI 0.78-1.57) in short term. Contradiction in results and the heterogeneity of interventions with electromagnetic field and ionization studies made it difficult to draw conclusions. Heterogeneity of US and phonophoresis studies also made pooling difficult and according to best evidence synthesis there was insufficient evidence to either support or refute the use of US as a unimodal treatment for LET when comparing with active treatments or placebo. There was also found that a marginal advantage existed over long term in using a combined physical intervention approach of deep friction massage, US and exercise when comparing with corticosteroid injection but not with wait and see policy.

Bjordal et al. (72) concluded that Low Level Laser Therapy 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 (SMD 17.2: 95% CI 8.5-25.9) and improved function (SMD 1.53: 95% CI 1.28-1.83) both alone and with an exercise regimen. 12 RCTs were included.

The review by Trudel et al. (98) included 33 studies and it was determined that there was at least level 2b evidence (Sacketts' Level of Evidence) in favor of ultrasound, phonophoresis, Rebox and ionization with diclofenac in regard to pain reduction and improvement in function. Laser therapy and pulsed electromagnetic field therapy were concluded to be ineffective with also at least level 2b evidence. Pooling of RCTs was not performed and quality assessment was done according to MacDermit.

van der Windt (99) located seven RCTs using US on LET. Statistical pooling was feasible and produced a pooled estimate for the difference in success rate of 15% (95% CI -8-38%) and this finding warranted for further investigations. Nimgade et al. (54) concluded that evidence for ultrasound was found to be neutral or insufficient.

Michener et al. (REF) studied the effectiveness of different treatment methods on subacromial impingement syndrome (SIS). Their conclusion was that there is limited evidence in support of laser in decreasing pain and improving function but ultrasound and seem to have no benefit. They evaluated the methodological quality of RCTs with quality list according to Sackett's guidelines, which includes 23 items and accounts for total of 69 possible points.

Faber et al. (42) reviewed the literature regarding treatment of impingement syndrome on functional outcomes. They included 13 RCTs which were assessed for quality using a list combining the criteria of the lists of Jadad et al and Verhagen et al. Of the included studies 6 were of high quality. They concluded that there was strong evidence that extracorporeal shock-wave therapy is not effective. For other interventions there is only limited evidence.

The review by Bizzini et al. (83) investigated treatments reducing pain in patients with PFPS. They used a scale they also had pilot tested to evaluate quality of RCTs included. Their conclusion was that combination of exercises with patellar taping and biofeedback was effective.

The review by Brosseau et al. (100) investigated effects of therapeutic ultrasound on PFPS. They used Jadad and Clark scales to perform the quality assessment. They found only one RCT that met the inclusion criteria. Their conclusion was that therapeutic ultrasound did not demonstrate clinically important benefit when compared to cryotherapy alone in treating PFPS. This review was updated in 2009 and there was no new data found to change the results. The only RCT evaluated in this review was same study by Antich et al that was also evaluated in the review by Bizzini et al. (2003).

van Leeuwen et al. (101) investigated the use of extracorporeal shockwave therapy (ESWT) for patellar tendinopathy. They used the Delphi score to evaluate the methodological quality. Conclusion was that ESWT seems to be safe and promising treatment with a positive effect on pain and function.

McLauchlan et al. (102) wanted to assess the effectiveness of various treatment interventions for acute and chronic Achilles tendinitis in adults. They evaluated the methodological quality of RCTs with evaluation tool used by the Cochrane Bone, Joint and Muscle trauma group which was modified subject-specific and piloted. Their conclusion was that none of the studies provided conclusive evidence of effect or no effect. Problems were detected with lack of statistically significant differences and small sample sizes.

Systematic review by De Vera Barredo et al. (54) concluded that there was good evidence in support of ESWT based on both the number and methodological strength which was in contrast with previous guidelines. Pooling of RCTs was not performed.

Crawford et al. (103) found that trial quality of included RCTs was generally poor in their systematic review and pooling could not be conducted. There was conflicting evidence for the effectiveness of low energy extracorporeal shock wave therapy in reducing night pain, resting pain and pressure pain in the short term. There was no evidence to support the effectiveness of therapeutic ultrasound, low-intensity laser therapy, exposure to an electron generating device or insoles with magnetic foil.

We located only one systematic review (38) covering Iliotibial Band Friction Syndrome. In this review there were only two RCTs included that covered conservative management. The quality of these trials was good and it was concluded that DTFM is not effective and the effectiveness of phonophoresis could not be considered conclusive due to methodological flaws.

In the review by Piazzini et al. (93) 18 RCTs were included and they were methodologically assessed according to the Cochrane Back Review Group. They concluded that ultrasound is effective while laser therapy shows variable results.

Muller et al. (104) located 24 RCTs regarding hand therapy interventions in primary management of carpal tunnel syndrome (CTS). Their conclusion stated that current evidence demonstrates a significant benefit from ultrasound and magnetic therapy for people with CTS. Studies' quality assessment was done using the Structured Effectiveness Quality Evaluation Scale (SEQES) and no statistical pooling was available.

Gerritsen et al. (105) found 6 RCTs covering conservative treatment for CTS. Methodological quality was assessed using Cochrane Back Review Group criteria and no statistical pooling was done. There was conflicting evidence that ultrasound is more effective than placebo in the short term and limited evidence for its long term effectiveness. Yoga and laser-acupuncture seem to be ineffective in short term and in long term splinting is less effective than surgery.

O'Connor et al. (40) included 14 RCTs which were quality assessed using Cochrane Reviewers' Handbook. They concluded that evidence shows significant short term benefit from ultrasound. Only data from two ultrasound treatment trials were pooled (not significantly better in short term) and no other data could be pooled to provide an estimate of the effect of any interventions included in our overview.



Table 6. Effectiveness of physical therapy modalities.

Systematic review (total number of studies)	Score	Type of conservative treatment	No RCTs'			Quality RCT (range/max)			Conclusions SR			Dissent	Conclusions Panel		
			A	B	C	A	B	C	A	B	C		A	B	C
LET															
<i>Bisset et al. 2005</i>	75	-Laser -ESWT - Electromagnetic field and ionisation -US and Phonophoresis -Combined physical interventions	1 2 1 2 1	 3 3 1	5     	8/15 11-12 8 8 13	 8-12 8-10 11	8-11	+/- +/- +/- ? +/-	  ? ? +	?	No long term follow up	? +/- +/- ? +/-	  ? ? +	?  ? ? +
<i>Bjordal et al. 2008</i>	64	-Low level laser therapy	11	1		4-8/11	7		+	++			+	+	
<i>Nimgade et al. 2005</i>	63	-Ultrasound -Ultrasound vs Manipulation		4 1			8/11 6.5			? +				? ?	
<i>Trudel et al. 2004</i>	78	-Ultrasound -Acupuncture -Rebox -Wait and See	2 5 1	4  1	  1	25 19-39	41/48	31	+	+		Flaws reporting in	? ? +	?  +	?  ?

		-Exercise		4		37				+					
		-Ionization	1	1		25-37	25			+	+		Quality	+/-	+/-
		-Pulsed Electromagnetic Field	1			25-36				+/-				-	
		-Manual Therapy	1	1			37			+	+			+	+
		-Laser	6			30-44				-				-	
van der Windt et al. 1999	81	Ultrasound	4	3	2-6/10	2-3				+	+/-		Poor quality	+	?
Total														?	?
SHOULDER/SIS															
Michener et al. 2004	67	-Laser	2	1		33,5-39	38,5			+	-		Quality of studies, heterogeneity	+	-
		-Ultrasound		1			38,5			-	-			-	-
		-Acupuncture	1	1		34/69	39			-	?			-	?
Faber et al. 2006	67	-ESWT	2			7-8/11				-			Cuff repair studies included	-	?
		-Laser	1	1		4-5				+/-	+/-			+/-	
		-Ultrasound	1			4				+/-				+/-	
Total														?	?
PFPS															
Bizzini et al. 2003	64	Modalities		2			20-55/100				-		Description of interventions and avoidance of cointerventions		-

												poor.			
<i>Brosseau et al. 2001</i>	84	<i>Ultrasound</i>	1			?			-				-		
<i>van Leeuwen et al. 2008</i>	60	<i>ESWT</i>	3	1		3-7/11	4/11		+	++		<i>Methodological quality, only one study</i>	+	+	
<i>Total</i>													?	?	
<b>Tendon</b>															
<i>McLauchlan et al. 2009</i>	88	<i>-Laser</i>	1			13/20			-				-		
<i>Total</i>													-		
<b>Plantar fasciosis</b>															
<i>De Vera Barredo et al. 2007</i>	61	<i>-ESWT</i>	4	2		5-7/7	5-6/7		++	++		<i>Quality studies of</i>	+	+	
<i>Crawford et al. 2003</i>	78	<i>-ESWT</i>	2	1		1/5	1/5		+	+/-			+	+/-	
<i>Total</i>													+	+	
<b>ITBFS</b>															
<i>Ellis et al. 2006</i>	76	<i>-Phonophoresis</i>		1			7/11			?				?	
<b>CTS</b>															
<i>Gerritsen et al. 2002</i>	72	<i>-Ultrasound -Laser -Splint</i>	2 1			4-8/11 5		4	+	+/-			+	?	
<i>Muller et al. 2004</i>	63	<i>-Ultrasound -Laser</i>	2		2	33-34	11-34/48		+	+		<i>Poor quality RCT's included</i>	?	?	

O'Connor et al. 2003	85	-Ultrasound -Magnetic Therapy	1 1	2		B B	C-A		+	+/-		High to moderate risk of bias	?	?	
Piazzini et al. 2007	61	-Ultrasound -Laser	2 1	2 1		4- 8/11 11 ?	? 10		+/-	+/-		Ratings unavailable	?	?	
Total													?	?	

A = Conservative treatment vs. no treatment, a placebo or a wait- and-see policy.

B = Conservative treatment vs. another treatment.

C= Comparing was not defined

Dissent = Disagreement between the conclusions in the systematic review and the conclusion of panel.

Ind = Insufficient evidence to support the effectiveness of conservative treatment defined, but there are indications to support the effectiveness

NA = Not applicable (was not investigated in the review).

RCT = Randomized controlled trial

SR= Systematic review

++ = Conservative treatment defined is effective compared to no treatments or other treatments

+ = Limited evidence compared to no treatments or other treatments

- = Conservative treatment defined is not effective compared to no treatment or other treatments

± = Conservative treatment defined is equally effective compared to no treatment or other treatments

? = Insufficient evidence to support or refute the effectiveness of conservative treatment defined

E= Exclusion from study, reason

LET = Lateral Elbow Tendinopathy

ESWT = Extra Corporeal Shockwave Therapy

US = Ultrasound

SIS = Shoulder Impingement Syndrome

PFPS = Patellofemoral Pain Syndrome

CTS = Carpal Tunnel Syndrome

ITBFS = Iliotibial Band Friction Syndrome

In summary there was insufficient evidence to support or refute the use of different physical therapy modalities in treating patients with LET. Long-term follow up is missing and there are flaws in methodology and the quality of studies is low.

In treating shoulder problems laser was effective in comparison with no treatment but there is insufficient evidence in support of any modality when compared to other treatment methods, because of heterogeneity and because some studies include cuff-repair operated patients. In treating PFPS ESWT is effective, but it is supported by only one study. US is not effective. In treating overuse injuries of tendon ESWT is effective in calcific tendinosis, but it is supported by only one high-quality study. Laser and ESWT in other types of tendon problems are not effective. In treating plantar fasciosis ESWT is effective compared to other methods or no treatment. In treating ITBFS or CTS evidence for the use of physical therapy modalities is inconclusive and there is high risk of bias in studies covering these subjects.

## **8.5 Splinting and braces**

We located 18 systematic reviews covering the effectiveness of physiotherapy. The quality scores ranged from 60 to 85 points (Table 7). The quality of the studies evaluated according to Bizzini, Cochrane, Delphi, Jadad, McDermit, Pedro, and van Tulder scales are shown in table 7.

Bisset et al. (85) conducted a comprehensive systematic review. 29 studies were included and they were assessed for quality using PEDro scale. No firm conclusions on orthotics or taping were drawn from three heterogenic studies.

Borkholder et al. (106) identified one high quality and ten moderate quality studies that offered early positive but not conclusive support for the effectiveness of splinting.

Struijs et al. (107) found five RCTs but pooling was not possible due to large heterogeneity amongst trials and therefore no definitive conclusions were drawn concerning the effectiveness of orthotic devices for lateral epicondylitis.

First review by Rome et al. (108) was published in 2005. They evaluated the evidence from RCT's of interventions for prevention and management of lower limb stress fractures and stress reactions of bone in young active adults. They included 16 trials in their first review, of which 13 of prevention. Their conclusion was that rehabilitation of tibial stress fracture may be aided with pneumatic bracing, but more evidence is needed. Pooled results showed no significant difference in the mean time to starting functional progression. Total mean difference was -1.96 in favour of pneumatic brace (95%CI -8.81 to 4,90 days) but the two included RCT's were highly heterogenous. In returning to full activity results favored using pneumatic air brace. Total mean difference was -33.39 (95% CI -44.18 to -22.59 days).

Review by Gillespie et al. (109) supported the same conclusions, their study was published in 2000 and the study by Rome et al was an update to this. Shaffer et al issued update of the review of Rome's review in 2006, which did not change previous conclusions. Rome et al used their own methodological quality assessment form, which included seven items scoring from zero to three points per item.

The review by Bizzini et al. (83) investigated treatments reducing pain in patients with PFPS. Their conclusion was that the use of resistive brace and combination of exercises with patellar taping and biofeedback were effective. The use of soft foot orthotics in patients with excessive foot pronation appeared to decrease pain and patients who received exercise programs were discharged earlier from physical therapy.

Warden et al. (84) investigated the effectiveness of combining taping and bracing on PFPS. They also used the PEDro scale to evaluate methodological quality. Same

RCTs were found in this review as the previous ones (80). Conclusion was that tape applied to exert a medially-directed force on the patella produces a clinically meaningful change in chronic knee pain. The evidence on bracing was limited. Limitations were caused by heterogeneity in outcomes and publication bias.

McLauchlan et al. (102) wanted to assess the effectiveness of various treatment interventions for acute and chronic Achilles tendinitis in adults. They evaluated the methodological quality of RCTs with evaluation tool used by the Cochrane Bone, Joint and Muscle trauma group which was modified subject-specific and piloted. Their conclusion was that none of the studies provided conclusive evidence of effect or no effect. Problems were detected with lack of statistically significant differences and small sample sizes.

Systematic review by De Vera Barredo et al. (54) concluded that there was poor evidence in support of night splint use based on relatively low number of methodologically strong studies for plantar fasciitis. Orthoses were supported by moderate level studies and more studies supported use of custom vs. prefabricated orthoses. Two lower level studies supported the use of stretching. There was good evidence in support of extra corporeal shock wave therapy based on both the number and methodological strength which was in contrast with previous guidelines. Pooling of RCTs was not performed.

Crawford et al. (103) found that trial quality of included RCTs was generally poor in their systematic review and pooling could not be conducted. With chronic patients there was limited evidence for the effectiveness of dorsiflexion night splints in reducing pain.

In the systematic review by Hawke et al. (63) there was silver level evidence that custom-made foot orthoses are more effective than sham orthoses for improving function (WMD 5.10, 95% CI 2.43-18.18.37, WMD 10.40, 95% CI 0.22-20.58) but not



for reducing foot pain, in midterm (WMD 5.10, 95% CI -5.19-15.39) and long-term (WMD -2.50, 95% CI -12.55-7.55). Custom-made orthoses are not more effective than night splints but do increase the effectiveness of a standard intervention for foot pain of function in short and midterm. Custom-made orthoses are not more effective than prefabricated orthoses for reducing foot pain (SMD -0.11 95% CI -0.42-0.19) or improving function in short or midterm outcomes. The use of custom-made orthoses does not increase the effectiveness of a standard intervention of Achilles' tendon and plantar fascia stretching or night splints in shortterm. Custom-made orthoses were found to be less effective than combined treatment of manipulation/mobilization/stretching for foot pain reduction in short term (WMD -23.30, 95% CI -42.67- -3.93) but not after one (WMD -11.10, 95% CI -28.81-6.61) or two months (WMD -6.10, 95% CI -21.35-9.15). Overall they concluded that it is unclear if custom-made foot orthoses are effective for plantar fasciitis.

Lee et al. (110) found that there is evidence for the use of orthoses in short (24.1%, 95% CI: 19.7-28.50), intermediate (15.2%, 95% CI: 11.8-18.7) and long-term (37.0%, 95% CI: 32.3-41.9) effects on decreasing pain and foot function in patients with plantar fasciitis. Night splint group also improved in pain (17%, 95% CI: 8.9-25.2) but not for self-reported foot function. The overall level of studies was moderate.

Gerritsen et al. (105) found 6 RCTs covering conservative treatment for CTS. Methodological quality was assessed using Cochrane Back Review Group criteria and no statistical pooling was performed. Their conclusion was that in long term splinting is less effective than surgery.

Muller et al. (104) located 24 RCTs regarding hand therapy interventions in primary management of carpal tunnel syndrome (CTS). Their conclusion stated that current evidence demonstrates a significant benefit from splinting. Studies' quality assessment was done using the Structured Effectiveness Quality Evaluation Scale (SEQES) and no statistical pooling was available.

O'Connor et al. (40) included 14 RCTs which were quality assessed using Cochrane Reviewers' Handbook. They concluded that evidence shows significant short term benefit from splinting.

In the review by Piazzini et al. (93) 18 RCTs were included and they were methodologically assessed according to the Cochrane Back Review Group. They concluded that splints are effective if used full-time.

Table 7. Effectiveness of splinting/braces

Systematic review (total number of studies)	Score	Type of conservative treatment	No RCTs'			Quality RCT (range/max)			Conclusions SR			Dissent	Conclusions Panel		
			A	B	C	A	B	C	A	B	C		A	B	C
<b>LET</b>															
<i>Bisset et al. 2005</i>	75	-Orthotics and taping	1	1		9/15	8		+	+/-			+/-	+/-	
<i>Struijs et al. 2001</i>	73	Orthotic devices		5			3-9/11			+/-				+/-	
<i>Total</i>													+/-	+/-	
<b>Stress reactions of bone</b>															
<i>Rome et al. 2005</i>	85	Pneumatic air brace	3			7-11/18			+			Included only three low methodological quality RCTs	?		
<b>PFPS</b>															
<i>Bizzini et al. 2003</i>	64	Orthotics -foot orthoses -patellar braces -elastic sleeves	1 1	1 1		65/100 25	25 30		+/-	- -		Description of interventions and avoidance of cointerventions poor.	?	- -	
<i>Warden et al. 2008</i>	80	Patellar bracing	2	3		3-4/11	2-3/11		+/-	+/-		Low quality studies, co-interventions?	+/-	-	
<i>McLauchlan et al. 2009</i>	88	-Heel pad	1			8			-				-		



A = Conservative treatment vs. no treatment, a placebo or a wait- and-see policy.

B = Conservative treatment vs. another treatment.

C= Comparing was not defined

Dissent = Disagreement between the conclusions in the systematic review and the conclusion of panel.

Ind = Insufficient evidence to support the effectiveness of conservative treatment defined, but there are indications to support the effectiveness

NA = Not applicable (was not investigated in the review).

RCT = Randomized controlled trial

SR= Systematic review

++ = Conservative treatment defined is effective compared to no treatments or other treatments

+ = Limited evidence compared to no treatments or other treatments

- = Conservative treatment defined is not effective compared to no treatment or other treatments

± = Conservative treatment defined is equally effective compared to no treatment or other treatments

? = Insufficient evidence to support or refute the effectiveness of conservative treatment defined

E= Exclusion from study, reason

LET = Lateral Elbow Tendinopathy

PFPS = Patellofemoral Pain Syndrome

CTS = Carpal Tunnel Syndrome

In summary braces are effective compared to no treatment when treating patients with LET, but when compared to other methods there is no conclusive result.

In treating stress reactions of bone there is evidence in support of using splinting but it is supported by three low-quality studies. In treating PFPS there is evidence supporting that biomechanical problems of foot, for example excessive pronation can be corrected but it is not always the reason behind this problem. So there is inconclusive evidence in support of foot orthotics compared to no treatment. Patellar braces and elastic sleeves are not effective in comparison with other treatment methods. In treating Achilles tendon injuries, heel pads are not effective. Foot orthotics are effective in treating plantar fasciitis when compared to no treatment or placebo but when compared to other treatment methods the evidence is inconclusive. There is only inconclusive evidence in support of bracing in the treatment of CTS.

## **8.6 Manual therapy and neural gliding**

We located 11 systematic reviews covering the effectiveness of physiotherapy. The quality scores ranged from 63 to 85 points (Table 8). The quality of the studies evaluated according to Bizzini, Cochrane, McDermit and Pedro scales are shown in table 8.

Bisset et al. (85) conducted a comprehensive systematic review. 29 studies were included and they were assessed for quality using PEDro scale. Elbow manipulation techniques RCTs data from two studies was pooled showing a positive immediate effect of manipulation on measured of pain free grip strength (SMD 1.28; 95% CI 0.84-1.73) and pressure pain threshold (SMD 0.49; 95% CI 0.08-0.90). They found also one RCT covering wrist manipulation with statistically insignificant findings on any outcome.

Initial results in the systematic review by Herd et al. (96) on the effectiveness of manipulative therapy support the use of Mulligan's mobilization with movement in providing immediate, short and long term benefits. In addition positive results were demonstrated with manipulative therapy directed at the cervical spine.

Nimgade et al. (54) concluded that in the short term steroid injections and physiotherapy outperformed rest. Evidence for manipulation (massage) was found to be neutral or insufficient.

The review by Trudel et al. (98) included 33 studies and it was determined that there was at least level 2b evidence (Sacketts' Level of Evidence) in favor of manipulation/mobilizations in regard to pain reduction and improvement in function. Pooling of RCTs was not performed and quality assessment was done according to MacDermid.

The objective of review by Camarinos et al (60) was to identify the effectiveness of manual therapy to the painful conditions of the glenohumeral joint. They used the PEDro scale to evaluate the quality of included seven articles. Their conclusion was that there is benefit of manual therapy for improvements in mobility and a trend in improving pain measures. There is no evidence supporting one form of manual therapy over another.

Desmeules et al. (43) evaluated the effectiveness of therapeutic exercise and orthopedic manual therapy for the treatment of impingement syndrome. They used Cochrane Musculoskeletal Injuries Group quality assessment scale to evaluate the methodological quality of seven RCT's included in their study. Their conclusion was that there is limited evidence to support the efficacy of combining therapeutic exercise and manual treatment in treating impingement syndrome.

Ho et al. (61) studied the effectiveness of manual therapy in the management of shoulder disorders. They found a total of fourteen RCT's which were evaluated with the PEDro scale. They found no clear evidence to suggest additional benefits from manual therapy to other interventions, which were exercise therapy, cryotherapy, electrotherapy, massage or manipulation or combinations of them. Six RCTs studied the effects on adhesive capsulitis and eight studied the effects on shoulder impingement syndrome. High grade manual therapy seemed to be more effective than low grade manual therapy. Meanwhile the problem was that the definition of manual therapy is very heterogenous and the quality of studies was not considered very high.

Trampas et al. (54) identified 5 RCTs (one low, two moderate and two high quality) assessing the effectiveness of manual and exercise therapy in the treatment of shoulder impingement. 4 of the RCTs were published after Faber's review. Methodological flaws preclude strong conclusions but it appeared that manual and exercise therapy may be more effective than other interventions especially in short term. There is moderate evidence that supports the use of therapeutic exercises alone and limited evidence supporting the use of both manual and exercise therapy in combination.

The review by Bizzini et al. (83) investigated treatments reducing pain in patients with PFPS. One of their objectives was to develop a grading scale to judge the quality of clinical trials to allow efficient synthesis and dissemination of literature. They used a scale they also had pilot tested to evaluate quality of RCTs included. Their conclusion was that combination of exercises with patellar taping and biofeedback were effective.

Medina McKeon et al. (111) focused on neural gliding techniques for the treatment of CTS locating 6 RCT, which were quality assessed using PEDro scale. They concluded that for all variables none were consistently favorable toward neural



gliding over alternative treatment and the efficacy of neural gliding is not clear. There is however a possible trend toward improved outcomes with the use of neural gliding.

Muller et al. (104) located 24 RCTs regarding hand therapy interventions in primary management of carpal tunnel syndrome (CTS). Their conclusion stated that current evidence demonstrates a significant benefit from nerve gliding exercises, carpal bone mobilization for people with CTS. Studies' quality assessment was done using the Structured Effectiveness Quality Evaluation Scale (SEQES) and no statistical pooling was available.

O'Connor et al. (40) included 14 RCTs which were quality assessed using Cochrane Reviewers' Handbook. They concluded that evidence shows significant short term benefit from carpal bone mobilization.

Table 8. Effectiveness of manual therapy and neural gliding

Systematic review (total number of studies)	Score alustava	Type of conservative treatment	No RCTs'			Quality RCT (range/max)			Conclusions SR			Dissent	Conclusions Panel		
			A	B	C	A	B	C	A	B	C		A	B	C
LET															
<i>Bisset et al. 2005</i>	75	-Manipulation techniques	2	1		11-13/15	8		+	+/-			+	+/-	
<i>Herd et al. 2008</i>	63	Manipulative therapy	2	2		5-8/11 3-4	4-8		+	+		Only immediate effect Risk of bias	+	+	
		-Mobilization with Movement	2	1			6		+	+			?	+	
		-Mobilization of the Cervical Spine		3							+/-				+/-
<i>Nimgade et al. 2005</i>	63	-Manipulation vs		1			6/11			+				?	
		-Injection vs		1			6			+				?	
		-Ultrasound vs Manipulation		1			6.5				+				?
<i>Trudel et al. 2004</i>	78	-Manual Therapy	1	1			37/48	31	+	+			+	+	
<i>Total</i>													+	+	

SHOULDER/SIS																
<i>Camarinos et al. 2010</i>	77	<i>Manual therapy</i>	1	6		9	6-9/11		++	+		<i>Heterogeneity in techniques used and flaws in reporting techniques and measurements</i>	+	?		
<i>Desmeules et al. 2003</i>	65	<i>Manual treatment</i>		3			14-16/24			+		<i>Low methodological quality of studies</i>		?		
<i>Ho et al. 2009</i>	79	<i>Manual therapy</i> <i>-modalities</i> <i>-exercises</i> <i>-medical care</i> <i>-injections</i>	4	2 1 4 1 2		3-8	7/11 6 4-6 8 3-5		+	+	+/ +? +/ +/-	<i>Definition of MT, reporting of treatment, confounding factors</i>	+	+	?	?
<i>Trampas et al. 2006</i>	65	<i>-Manual Therapy vs Exercise</i>		1			4/11		+					?		
<i>Total</i>													+	?		
PFPS																
<i>Bizzini et al. 2003</i>	64	<i>Manual therapy</i>	1	1		55	80/100		?	?		<i>Description of interventions and avoidance of cointerventions poor.</i>	?	?		
CTS																
<i>McKeon et al. 2008</i>	83	<i>-Neural Gliding Technique +</i>		5			4-5/10		?			<i>Inconclusive results</i>		?		

		<i>Splint</i> <i>-Neural Gliding</i> <i>-Neural Gliding</i>	1	1		4 4			+	?			?	?		
<i>Muller et al. 2004</i>	63	<i>-Nerve Gliding Exercises</i> <i>-Manual Therapy</i>		2 2		11-34	27-34/48			+	+		<i>Poor quality RCT's included</i>	?	?	
<i>O'Connor et al. 2003</i>	85	<i>-Nerve Gliding</i>	1	1		C	C		+/-	+/-			<i>High to moderate risk of bias</i>	?	?	
<i>Total</i>														?	?	

A = Conservative treatment vs. no treatment, a placebo or a wait- and-see policy.

B = Conservative treatment vs. another treatment.

C= Comparing was not defined

Dissent = Disagreement between the conclusions in the systematic review and the conclusion of panel.

Ind = Insufficient evidence to support the effectiveness of conservative treatment defined, but there are indications to support the effectiveness

NA = Not applicable (was not investigated in the review).

RCT = Randomized controlled trial

SR= Sytematic review

++ = Conservative treatment defined is effective compared to no treatments or other treatments

+ = Limited evidence compared to no treatments or other treatments

- = Conservative treatment defined is not effective compared to no treatment or other treatments

± = Conservative treatment defined is equally effective compared to no treatment or other treatments

? = Insufficient evidence to support or refute the effectiveness of conservative treatment defined

E= Exclusion from study, reason

LET = Lateral Elbow Tendinopathy

SIS = Shoulder Impingement Syndrome

PFPS = Patellofemoral Pain Syndrome

CTS = Carpal Tunnel Syndrome

In summary manual therapy is with limited evidence effective in treating LET. When treating shoulder overuse injuries manual therapy is effective compared to no treatment but due to heterogeneity and low quality of studies the effectiveness compared to other methods is inconclusive. In treating PFPS and CTS the evidence is again inconclusive because poor description of studies and avoidance of co-interventions. Deep tissue friction massage is not effective in LET or ITBFS when compared to other treatment methods.

## **8.7 Acupuncture**

We located 18 systematic reviews covering the effectiveness of physiotherapy. The quality scores ranged from 60 to 85 points (Table 6). The quality of the studies evaluated according to Bizzini, Cochrane, Delphi, Jadad, McDermid, Pedro, and van Tulder scales are shown in table 5.

Bisset et al. (85) conducted a comprehensive systematic review. 29 studies were included and they were assessed for quality using PEDro scale. No pooling was performed on studies covering acupuncture due to differences in the applied interventions and timing of outcome assessment but there appears to be some evidence to support the efficacy over placebo in short term and no difference between US and acupuncture.

Green et al. (112) located four small RCTs covering acupuncture for lateral elbow pain and found insufficient evidence to either support or refute the use of acupuncture. A meta-analysis was not able to be performed due to flaws in study designs.

Trinh et al. (113) concluded that there was strong evidence suggesting that acupuncture is effective on short term relief in lateral epicondyle pain.

The review by Trudel et al. (98) included 33 studies and it was determined that there was at least level 2b evidence (Sacketts' Level of Evidence) in favor of acupuncture in regard to pain reduction and improvement in function. Pooling of RCTs was not performed and quality assessment was done according to MacDermid.

Green et al. (114) studied the efficacy and safety of acupuncture in treating shoulder pain. They used their own validity criteria which included appropriate randomization, allocation concealment, blinding, number lost to follow up and intention to treat analysis, but they did not use numerical score. Only quantitative scoring was given for allocation concealment (a:adequate, b:unclear, c:inadequate). Their conclusion was that no firm conclusion can be drawn regarding the efficacy of acupuncture for shoulder disorders. Jing Luo technique showed greater results in one study versus traditional Chinese medicine acupuncture sites. Also one trial indicated that deep acupuncture was more effective than shallow acupuncture. Small trial showed positive signs in favoring acupuncture compared with exercise versus acupuncture alone.

Michener et al. studied the effectiveness of different treatment methods on subacromial impingement syndrome (SIS). Their conclusion was that there is no benefit in using acupuncture. They evaluated the methodological quality of RCTs with quality list according to Sackett's guidelines, which includes 23 items and accounts for total of 69 possible points.

The review by Bizzini et al. (83) investigated treatments reducing pain in patients with PFPS. Their conclusion was that acupuncture was effective.

Muller et al. (104) located 24 RCTs regarding hand therapy interventions in primary management of carpal tunnel syndrome (CTS). Their conclusion stated that current

evidence demonstrates a significant benefit from splinting, ultrasound nerve gliding exercises, carpal bone mobilization, magnetic therapy and yoga for people with CTS. Studies' quality assessment was done using the Structured Effectiveness Quality Evaluation Scale (SEQES) and no statistical pooling was available.

O'Connor et al. (40) included 14 RCTs which were quality assessed using Cochrane Reviewers' Handbook. They concluded that evidence shows significant short term benefit from splinting, ultrasound, yoga and carpal bone mobilization. Only data from two ultrasound treatment trials were pooled (not significantly better in short term) and no other data could be pooled to provide an estimate of the effect of any interventions included in our overview.



Table 9. Effectiveness of acupuncture

Systematic review (total number of studies)	Score	Type of conservative treatment	No RCTs'			Quality RCT (range/max)			Conclusions SR			Dissent	Conclusions Panel		
			A	B	C	A	B	C	A	B	C		A	B	C
<b>LET</b>															
<i>Bisset et al. 2005</i>	75	-Acupuncture	3	1		8/15	10		+	+/-			+	+/-	
<i>Green et al. 2002</i>	85	-Acupuncture	4			B-D			?				?		
<i>Trinh et al. 2004</i>	62	Acupuncture	4	2		3-5/5	3		++	++		Only short term effect	?	?	
<i>Trudel et al. 2004</i>	78	-Acupuncture	5			19-39/48			+			Flaws in reporting	?		
<i>Total</i>													?	+/-	
<b>SHOULDER/SIS</b>															
<i>Green et al. 2008</i>	87	Acupuncture -with mobilization -with exercise -deep versus shallow -different techniques	2	1 1 1 1		a,c	a b b a		+/-	+/- +/- +/- +/-		Low amount of studies, varying methodological quality	+/-	+/- +/- +/- +/-	
<i>Michener et al. 2004</i>	67	-Acupuncture	1	1		34/69	39		-	?		Quality of studies, heterogeneity	-	?	
<i>Total</i>													-	+/-	

PFPS															
<i>Bizzini et al. 2003</i>	64	<i>Acupuncture</i>		1			55/100		++			<i>Description of interventions and avoidance of cointerventions poor. Only one study</i>	+		
CTS															
<i>Muller et al. 2004</i>	63	<i>-Acupuncture</i>			1			15/24			?	<i>Poor quality RCT's included</i>			?
<i>O'Connor et al. 2003</i>	85	<i>-Acupuncture</i>	1			<i>B</i>			+/-			<i>High to moderate risk of bias</i>	?		
<i>Total</i>													?		?

A = Conservative treatment vs. no treatment, a placebo or a wait- and-see policy.

B = Conservative treatment vs. another treatment.

C= Comparing was not defined

Dissent = Disagreement between the conclusions in the systematic review and the conclusion of panel.

Ind = Insufficient evidence to support the effectiveness of conservative treatment defined, but there are indications to support the effectiveness

NA = Not applicable (was not investigated in the review).

RCT = Randomized controlled trial

SR= Systematic review

++ = Conservative treatment defined is effective compared to no treatments or other treatments

+ = Limited evidence compared to no treatments or other treatments

- = Conservative treatment defined is not effective compared to no treatment or other treatments

± = Conservative treatment defined is equally effective compared to no treatment or other treatments  
? = Insufficient evidence to support or refute the effectiveness of conservative treatment defined

E= Exclusion from study, reason

LET = Lateral Elbow Tendinopathy

SIS = Shoulder Impingement Syndrome

PFPS = Patellofemoral Pain Syndrome

CTS = Carpal Tunnel Syndrome

Summary concerning the use of acupuncture is that the effectiveness of acupuncture is unclear in LET and CTS. In treating SIS there is no effect when compared to no treatment or other treatment methods. When treating PFPS acupuncture is effective compared to other treatments according to one study, where co-interventions were not avoided properly.

## **8.8 Deep Tissue Friction Massage**

We located 2 systematic reviews covering the effectiveness of physiotherapy. The quality scores ranged from 60 to 85 points (Table 10). The quality of the studies evaluated according to Cochrane and Pedro scales are shown in table 10.

Brosseau et al. (115) found one RCT studying the efficacy of deep transverse friction massage for treating extensor carpi radialis tendinopathy and no statistically significant difference in pain intensity, grip strength and functional status was found compared with combined physiotherapy modalities.

We located only one systematic review (38) covering Iliotibial Band Friction Syndrome. In this review there were only 1 RCTs included that covered conservative management. The quality of the trial was good and it was concluded that DTFM is not effective.

Table 10. Effectiveness of deep tissue friction massage

Systematic review (total number of studies)	Score	Type of conservative treatment	No RCTs'			Quality RCT (range/max)			Conclusions SR			Dissent	Conclusions Panel		
			A	B	C	A	B	C	A	B	C		A	B	C
LET															
<i>Brosseau et al. 2002</i>	87	-Deep Tissue Friction Massage		1			4/5			-				-	
ITBFS															
<i>Ellis et al. 2006</i>	76	-Deep Transverse Friction Massage		1			7/11			-				-	

A = Conservative treatment vs. no treatment, a placebo or a wait- and-see policy.

B = Conservative treatment vs. another treatment.

C= Comparing was not defined

Dissent = Disagreement between the conclusions in the systematic review and the conclusion of panel.

Ind = Insufficient evidence to support the effectiveness of conservative treatment defined, but there are indications to support the effectiveness

NA = Not applicable (was not investigated in the review).

RCT = Randomized controlled trial

SR= Systematic review

++ = Conservative treatment defined is effective compared to no treatments or other treatments

+ = Limited evidence compared to no treatments or other treatments

- = Conservative treatment defined is not effective compared to no treatment or other treatments

± = Conservative treatment defined is equally effective compared to no treatment or other treatments

? = Insufficient evidence to support or refute the effectiveness of conservative treatment defined

E= Exclusion from study, reason  
LET = Lateral Elbow Tendinopathy

ITBFS = Iliotibial Band Friction Syndrome

## 9. COMMENTS

There is little or inconclusive evidence in support to any specific form of conservative treatment in the management of overuse injuries. Some interventions show promising treatment effects but methodological flaws both in the reviews and included trials decrease the level of evidence. Methodological flaws in the systematic reviews comprise of poor study selection, methodological quality assessment, intervention description, data presentation and evaluation of the studied intervention.

Description of inclusion and exclusion criteria was usually sufficient but included interventions and outcome types were merely defined by the studies included rather than that they were already decided beforehand. Search strategies were depicted variably but since the cut-off point was set to 60 points most of the included reviews were well conducted and used several established databases. Some reviews included also lower quality studies (not RCTs) in their synthesis which made it more difficult to interpret the findings and this might have lead to overestimating the efficacy of the intervention effect.

Methodological quality assessments of studies included in the reviews were carried out using several different assessment scales or tools. This caused significant variability on the scores they received from us on the validity assessment because our assessment tool required certain details to be described for the study to receive the points in that category. Number, blinding and agreement of reviewers were reported also quite variably.

Intervention description was dependant on the type of management. Physical modality therapies were reported thoroughly where as physiotherapy, taping or orthose interventions were more vaguely defined. Exercise interventions were sometimes clearly reported but on the other hand there were studies where the

exercises were not described at all. The form and type of exercise should be reported so that conclusions about different types exercises could be drawn.

Some reviews presented data outstandingly while others settled only for brief comments. Usually Cochrane reviews presented outcomes using original data, mean difference, confidence interval and tree plots. Some lower quality studies reported only the original data from the included study. The lack of statistical pooling was evident in lot of the reviews due to heterogeneity in the included studies and the power of negative RCTs were similarly seldom calculated.

Most reviews presented thorough discussion identifying strengths and weaknesses of the review. Problems with disease classification, variety of treatment interventions and methodological quality of RCTs caused the overall conclusion of the aggregated level on the effectiveness of the intervention to be less than strong in most cases.

Management of several injuries by conservative measures may rely on clinical expertise due to limitations in evidence. While description of the intervention is just active physiotherapy or custom made foot orthose there is deep need for reporting these interventions as clearly as possible. On the other hand this practical knowledge might generate new ideas how to treat injuries.

New knowledge to ethiology of different injuries changes the definitions of these injuries all the time which may lead to completely new ways and ideas how to manage overuse injuries. Could preventive measures also be effective in treatment like in the management of chronic athletic groin pain? Clinical tools for diagnosing different overuse injuries in functional way should be developed instead of just pinpointing the target tissue as the source of pain and limitation in function. This might proof to be hard because of the heterogeneity of people but developing physical screens for malalignment, muscular imbalance, muscle weakness, inflexibility and instability for overuse injuries should not be too overwhelming.



Some conditions are also only covered by low-quality reviews, such as management of stress reactions of bone. According to only one systematic review, the use of pneumatic bracing might have some positive effects, but more research is needed to confirm this. About the management of spondylolysis, no conclusions can be drawn because we could not find any high quality systematic reviews. There are forms of overuse injuries that are not covered in this review because there is not enough high-quality research available.

In addition to these systematic reviews about conservative treatment of different overuse injuries, we found also three reviews (112, 113, 114) about the effectiveness of singular treatment methods in rehabilitation. Lewis et al (116) studied the clinical effectiveness of therapeutic massage for musculoskeletal pain. Their conclusion was that evidence is inconclusive. Derry et al (117) published a systematic review of systematic reviews of acupuncture published 1996-2005. Their conclusion was that there is no evidence in favor of acupuncture in any indication and positive results that have been found in some reviews are likely to be biased. Durall et al (118) published a systematic review comparing implications for rehabilitation about single-set versus multiple-set resistance-training randomized controlled trials. Their conclusion was that multiple-set protocols are more effective than single-set protocols for healthy individuals, but because none of studies included patients undergoing rehabilitation no conclusions can be drawn about the effect on management of overuse injuries. van der Windt et al (99) reviewed ultrasound therapy for musculoskeletal disorders and their conclusion was that there is no conclusive evidence in favor of ultrasound treatment but more investigation is needed.

There are also limitations in this review. In literature search, we found some review articles that were written in Chinese, German and Spanish that we did not include due to language restriction. These articles could have evidence that would add information to the results of this review. Also results of the latest RCT's are not considered and discussed in the light of evidence found in this particular review.

## **9.1 Implications for research and practice**

There is dearth of good quality evidence for the management of overuse injuries. Well conducted RCT are in need and developing new clinical assessment tools for diagnosing should be considered.

There seems to be a trend in favor of active approaches in the management of overuse injuries. They seem to be more effective and cost effective than passive treatments.

## 10. CONCLUSIONS

Some conclusions can be drawn from preceding tables, but because different treatment methods can vary considerably when applied to different overuse injuries it is difficult to make clear statements.

In short conclusion, it seems that there is limited evidence that:

- Taping is effective especially when combined with other treatment methods.
- Exercise therapy is effective.
- Physical therapy (combined treatments) is equally effective as other methods.
- Physical therapy modalities are not effective, except ESWT.
- Splinting and braces are effective compared to no treatment, but results are unclear when compared to other methods.
- Effectiveness of manual therapy is unclear due to flaws in reporting.
- Acupuncture is not effective, but some positive effects are seen in short term.

## **11. ACKNOWLEDGEMENTS**

Adjunct professor Erkki Alanen for helping with statistical part of this study.



Appendix 1 Breakdown of final scores for each criterion on systematic reviews included in analysis.

Review	Criteria																																Total							
	A					B		C	D						E	F	G	H				I			J				K	L				M	N					
Rome 2005	1	2	3	4	5	1	2	1	1	2	3	4	5	6	1	1	1	1	2	3	4	1	2	3	4	1	2	3	4	1	1	2	3	1	1	2	3	4	82	
van de Water 2010	2	2	2	2	2	5	5	10	2	0	2	2	0	2	4	0	2	3	0	2	2	3	2	2	5	0	0	0	3	0	0	1	5	0	0	0	2	2	74	
Brosseau 2001	0	2	2	2	2	5	5	10	0	0	2	2	0	0	4	0	0	3	0	2	2	3	2	2	5	3	3	3	3	3	0	0	5	4	2	0	2	83		
Kingma 2007	2	2	2	2	2	5	0	10	2	0	0	0	0	0	4	0	2	3	1	0	0	3	0	0	5	0	0	0	3	0	0	1	5	0	2	2	2	60		
Wasiliewski 2007	2	2	2	2	2	5	0	10	2	0	2	2	0	2	4	0	0	3	0	2	2	3	2	0	0	3	3	0	0	0	0	5	0	2	0	2	64			
Woodley 2007	2	2	2	2	2	5	5	10	2	0	2	2	0	2	4	0	0	3	0	2	2	3	0	0	5	3	3	3	3	0	0	1	5	0	2	2	2	81		
Brosseau 2002	2	2	2	2	2	5	5	10	0	0	2	2	0	0	4	0	0	3	0	2	2	3	2	2	5	3	3	3	3	3	0	0	5	4	2	2	2	87		
McLaughlan 2001	0	2	2	2	2	5	5	10	2	2	0	2	0	2	4	0	0	3	0	2	2	3	2	2	5	3	3	3	3	0	2	0	5	4	2	2	2	82		
Aminaka 2005	0	2	2	2	2	5	0	0	2	0	2	2	0	2	4	0	0	3	1	2	2	3	2	2	5	0	3	0	0	0	0	0	0	1	5	4	2	0	2	62
Bizzini 2003	2	2	0	2	2	5	5	10	2	2	2	2	2	2	4	0	2	3	0	0	0	3	0	0	0	0	0	0	0	0	0	0	1	5	4	0	0	2	64	
Heintjes 2003	0	2	2	2	2	5	5	10	2	0	2	2	0	2	4	0	2	3	0	2	2	3	0	0	5	3	3	3	3	0	0	0	5	0	2	0	2	78		
Bjordal 2008	0	2	2	0	2	5	5	10	2	0	2	2	0	2	0	0	0	3	0	0	0	3	0	0	5	3	3	3	3	0	0	0	5	0	0	0	2	64		
Green 2002	0	2	2	2	2	5	5	10	2	2	2	2	2	0	4	2	0	3	0	2	2	3	2	2	5	3	3	3	3	3	0	0	5	0	0	0	2	85		
McKeon 2008	0	2	2	2	2	5	5	10	2	0	2	2	0	2	4	0	0	3	0	0	2	3	0	2	5	3	3	3	3	0	0	1	5	4	2	2	2	83		
Muller 2004	0	2	0	2	2	5	0	10	2	0	0	2	2	2	4	2	0	3	0	2	2	3	2	2	5	0	0	0	0	0	0	0	5	4	0	0	2	65		
Piazzini 2007	0	2	0	2	2	5	0	10	2	2	0	2	2	2	4	0	0	3	0	2	2	3	2	2	5	0	0	0	0	0	0	0	5	0	0	0	2	61		
Faber 2006	2	2	2	2	0	5	5	10	2	2	2	2	2	2	4	0	0	3	0	0	0	3	0	0	5	0	0	0	3	0	0	0	5	0	2	0	2	67		
Ellis 2007	0	2	2	2	2	5	5	10	2	0	2	2	0	2	4	0	0	3	0	2	2	3	2	2	5	0	0	0	0	0	0	5	4	2	0	2	72			
Desmeul	0	2	0	2	0	5	5	10	2	2	0	2	2	2	4	0	0	3	0	0	0	3	0	0	5	0	0	0	3	0	2	0	5	0	0	0	2	61		







## Appendix 2. Criteria for the assessment of the quality of the systematic reviews.

Criteria Maximal points

### *Study selection (30)*

A Description of inclusion and exclusion criteria of the systematic review

- 1 Study setting(s) included (i.e. industry, general practice, hospital) 2
- 2 Interventions type(s) included 2
- 3 Outcome type(s) included (i.e. pain, general improvement, disability questionnaire) 2
- 4 Years covered 2
- 5 Language(s) covered 2

B Search strategy

- 1 Established bibliographic database included (Medline (or PubMed), and at least one other database) 5
- 2 Additional efforts to locate non-indexed randomised clinical trials (RCTs) (e.g. reference tracking, correspondence with experts, manual search of non-indexed journals) 5

C Emphasis on RCTs: RCTs only, or results or RCTs discussed separately from other study designs 10

### *Methodological Quality Assessment (20)*

D Assessment (of the validity) of RCTs included that is explicit (reproducible by readers of the review) regarding:

- 1 Similarity of treatment groups at baseline (prognostic factors) 2
- 2 Similarity of treatment characteristics (co-interventions) 2
- 3 Adequacy of treatment of missing values (dropouts, loss to follow-up) 2
- 4 Blinding of outcome assessment 2
- 5 Relevance of outcome measures 2
- 6 Adequacy of statistical analysis (i.e. intention-to-treat analysis) 2

E Number of reviewers (at least two independent reviewers) 4

F Blinding of reviewer(s): (blinded for source of article: journal, year of the trial, publication, institute) 2

G Agreement of reviewer(s): reported (quantitatively in percentage agreement or Kappa statistics) and acceptable

(cut-off Kappa statistics > 0.60, where Kappa statistics is not reported look at percentage agreement, which should be at least 80%). In the event of reviewer, use of an assessment list with established reliability. 2

### *Intervention (15)*

H Description of (index) intervention(s) (exercises) per RCT

- 1 Description of therapeutic exercise (i.e. strength, endurance and cardiovascular fitness, mobility 3 and flexibility, stability, relaxation, coordination, balance, and functional skills)
- 2 Profession or training of care provider 1
- 3 Treatment frequency or number of treatments 2
- 4 Duration of treatment period 2

I Description of control intervention(s): per RCT

- 1 Type (e.g. conservative treatments, wait-and-see policy, surgery) 3
- 2 Treatment frequency or number of treatments 2
- 3 Duration of treatment period 2

### *Data Presentation (20)*

J Outcome presentation (for the most important (clinical relevant) outcome measures)

- 1 The original data of the main outcome(s) are presented separately per RCT per group 5
- 2 Presentation of the mean difference (effect size, standardised mean differences, weighted mean differences) or ratio of outcome(s) (relative risk, risk difference, odds ratio) between intervention group(s) and

control group(s) 3

3 Presence of confidence interval (i.e. 95% CI) or standard deviation (SD) per RCT 3

4 Graphic presentation of the most important outcome(s) (indicating outliers and distribution) per RCT (presentation of a tree plot, meta-analysis)

K Adequate summary of research findings: statistical pooling of the most important outcome(s); discussion of the reason why pooling is not indicated or warranted; or pooling of the subset considered to be valid and similar enough 3

L Discussion of the power of negative RCTs

1 Calculation (quantitative) of the power of each RCT 3

*or*

2 Narrative elaboration (qualitative) on the power of each negative RCT 2

*or*

3 Overall narrative elaboration on the power of the negative RCTs (i.e. remarks about small sample sizes) 1

*Evaluation (15)*

M Overall conclusion regarding the aggregated level of available RCTs on the effectiveness of the (index) intervention presented 5

N Discussion of heterogeneity of RCTs and outcomes

1 Identification of relevant subgroups (e.g. age, study setting, disease classification) with explicit motivation 4

2 Discussion of variety of treatment modalities in the intervention groups (i.e. high dose exercises) 2

3 Discussion of variety of treatment modalities in control groups (placebo, existing modality) 2

4 Discussion of relationship between methodological quality of RCTs and outcome 2

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