REVIEW ARTICLE

CONTENTS

Effectiveness of non-operative methods of treatment of carpal tunnel syndrome: a narrative review

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ABSTRACT

Carpal tunnel syndrome (CTS) can be treated with several methods, including surgical and non-surgical techniques. Non-surgical methods include wrist splinting, systemic pharmacotherapy, intracarpal injections of steroids hydrodissection, acupuncture, nerve and tendon mobilization, osteopathy, taping, topical application of ointments, laser, ultrasound and shock-wave therapies. These treatments are generally less effective than surgery, and provide only short-lived effect, but it may be quite sufficient for a certain category of patients, particularly those suffering from mild symptoms. Over the last years, these techniques have attracted increasing popularity, because they offer non-invasive option for surgical treatment what can be attractive for some patients. However, although these methods were shown in the literature, their actual effectiveness has not been scientifically verified. The objective of this study was a review of the effectiveness of non-operative methods of treatment of CTS. A review of the published literature from PubMed and Medline databases on the effectiveness of CTS non-operative treatments of was done. The review indicates that each of the presented methods is effective in reduction of symptoms and improvement of hand function in CTS patients, but their effect is only short-lived. None of these treatments provides a permanent cure, like does surgical treatment. In spite of numerous non-operative treatments of CTS, surgery is the only method that provides permanent recovery.

KEY WORDS: carpal tunnel syndrome, non-operative treatment, outcomes of the treatment, literature review

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INTRODUCTION

Carpal tunnel syndrome (CTS) is caused by compression of the median nerve in the carpal tunnel. It is the most common compression neuropathy, affecting 1-1.5% of the total population and about 6% of women over 40 years of age. Middle-aged and elderly women are the largest group affected by this condition. The age of onset varies: in the clinic managed by the author, the average age of women admitted for carpal tunnel release was 57 years. Although several predisposing factors are known (diabetes, hypothyroidism, rheumatoid arthritis), in about 80% of cases the cause of the syndrome cannot be determined (an idiopathic syndrome) [1-8].

Carpal tunnel syndrome can be treated with several methods [1, 2, 6, 7]. Although surgical treatment (cutting of flexor retinaculum) is most often used, other, non-surgical methods have their place in the CTS management. These include immobilization of the wrist joint in a splint or orthosis, various methods of physiotherapy, systemic pharmacotherapy and local injections of steroids. Conservative treatment is generally considered to be less effective than surgery and only temporary effective, but it may be quite sufficient for a certain category of patients, particularly those suffering from mild symptoms. Over the last years, non-operative methods of treating carpal tunnel syndrome have to be offered, such as: hydrodissection, acupuncture, nerve and tendon mobilization, osteopathy, taping, topical application of ointments, as well as laser, ultrasound and shock-wave therapies. These techniques have attracted increasing popularity, because they offer non-invasive option for surgical treatment what can be attractive for some patients. However, although these methods were shown in the literature, their actual effectiveness has not been scientifically verified.

AIM

The objective of this study was to review an effectiveness of non-operative methods of the treatment of carpal tunnel syndrome.

MATERIAL AND METHODS

This article presents a review of the published literature from PubMed and Medline databases on the effec-

tiveness of non-operative treatments of carpal tunnel syndrome. A randomized clinical trials, systematic reviews and meta-analyses reporting on use of these methods were reviewed. Keywords used at searching articles were: carpal tunnel syndrome, non-operative treatment, clinical outcomes, treatment effectiveness, systematic review, meta-analysis and treatment complications.

REVIEW AND DISCUSSION

The results of the literature review will be presented separately for each non-standard treatment. First three paragraphs will end with the author's comment on the results presented.

HYDRODISSECTION

USG-guided injection (also named as hydrodissection or perineural injection) delivering a range of injectates, i.e. normal saline, corticosteroids, dextrose and platelet-rich plasma attracts growing popularity in the treatment of CTS [9-13]. In assumption, this procedure, provides a mechanical effect to release and decompress the entrapped nerves and adds a pharmacological effect of delivered drug relieving pain and promoting recovery. During hydrodissection, ultrasound guidance is used to identify the nerve and guide the needle to the nerve. After this, an adequate volume of an injectate is placed around the nerve to separate it from surrounding tissue, fascia, or adjacent structures that may be compressing the nerve. The volume of fluid injected into carpal tunnel varies from 4 to 10 ml. Depending on the patient, only one treatment may be needed, but this procedure typically needs to be repeated 2-3 times to achieve the expected result.

Several publications presenting effectiveness of this procedure using various injectates were published [9-13]. Most studies compared different ultrasound-guided interventions to different comparison injectate or other conservative treatments such as wrist splinting or physical therapy, but none compared a matched intervention and comparison groups. Various injectates were used such as 0,9% saline solution, 5% dextrose solution, corticosteroids, local anaesthetics, hyaluronic acid, platelet-rich plasma and ozone. Outcome measures after intervention included pain intensity in the Numeric Rank Scale (NRS, range 0-10, higher means stronger pain), Boston Carpal Tunnel Questionnaire (BCTQ; range 1-5, higher means worse symptoms and greater disability) and Disability of Arm, Shoulder and Hand questionnaire (DASH; range 0-100, higher means greater disability) as well as the electrodiagnostic studies. Results reported in these studies show generally good results after hydrodissection procedure using various injectates, in terms of cessation of pain, clinical improvement (decreasing of BCTQ and DASH scores) and improvement of electrodiagnostic parameters. All considered variables were statistically significantly better after treatment, comparing to baseline [10, 11].

Yang et al. reported results of investigations of efficacy of various injectates used in hydrodissection procedures in the treatment of carpal tunnel syndrome through a network meta-analysis of randomized control trials. Platelet-rich plasma was identified to be the most effective injectant for short-term functional improvement and pain relief. Platelet-rich plasma is the processed liquid fraction of autologous peripheral blood with a platelet concentration. The authors conclude that results of their network meta-analysis show that platelet-rich plasma can be used as first-line treatment for carpal tunnel syndrome, and other injectates such as 5% dextrose and steroids may serve as alternative treatments [13].

Interestingly, favourable outcomes after hydrodissection procedure were observed also in a control groups using injections with plain saline or local anaesthetics; unfortunately there were no clear placebo-controlled trials. However considering normal saline injection as placebo, these results may suggest that hydrodissection itself results in clinical improvement, regardless the injectate used [9, 11, 12]. No serious adverse events were reported after hydrodissection. Results of the analysis of literature on use of this procedure show that USG-guided hydrodissection is a safe but only temporary effective treatment for mild to moderate CTS. A major rationale for using this technique is to reduce the risk of iatrogenic nerve injury during blind intracarpal injection of various substances.

CRITICAL COMMENT

Current evidence supporting use of hydrodissection for carpal tunnel syndrome has a significant drawback: a short follow-up. Almost all studies presented results up to 6 months! There may be concern that after a longer time the symptoms may return in most patients. In essence, hydrodissection does not differ much from ordinary steroid or hyaluronic acid injections. Although it is ultrasound-guided and more fluid is injected into the carpal tunnel, but the procedure does not change anatomical relations in the carpal tunnel. The only procedure that changes the anatomical relations in the carpal tunnel is surgical cutting the flexor retinaculum. When all structures in the carpal tunnel remain unchanged, it is difficult to assume that the pressure on the me-

Fig. 1. Application of shock wave in carpal tunnel syndrome.

dian nerve, which was reduced after the intervention, will not return after a shorter or longer period of time. Therefore beneficial effect of hydrodissection reported in many studies should be treated with caution as potentially short-lived. The reviewed literature also did not provide any evidence that patients with CTS who underwent hydrodissection will avoid surgery in the future.Therefore the assurances of some doctors that hydrodissection is as effective treatment as surgery and without unpleasant adverse effects are unfair.

STEROID INJECTION

Intracarpal steroid injection is one of the most commonly accepted treatment among the various conservative managements for CTS. There are several supposed mechanisms of action of local steroids in carpal tunnel syndrome, including:

- Anti- inflammatory effect by inhibiting the production of inflammatory cytokines by lymphocytes and macrophages in the tenosynovium.
- Antifibrotic effect via the suppression of collagen expression.
- Anti-oedematous effects through reduced vascular permeability.

Activation of all these mechanisms results in a beneficial effect in the form of cessation of symptoms and improvement of hand function [13-17]. In some studies an improvement in electrophysiological parameters in the median nerve has also been observed [15, 17]. Basically 3 substances are used for injections: triamcinolone, methylprednisolone and betamethasone. Effectiveness all these injectates is similar and their use depends mainly on the individual surgeon's preference. Steroids are injected into carpal tunnel with landmark-guided technique or with USG guidance; the former technique is much more common, but it carries some risk of intraneural injection, even with correct needle insertion and localization. Therefore, ultrasound-guided injection is gradually applied for accurate localization of intracarpal structures. However, landmark-guided injection still seems to be one of the most available management procedures, attributed to good effectiveness, more convenience, and lower cost [17].

In general 1-3 injections at 2-4 week intervals are needed to achieve permanent improvement, but some patients respond excellently to one injection. Steroid injections provide a very quick relief of symptoms, usually within 24 hours after the injection, which is why patients often ask for such treatment. This applies especially to patients with severe symptoms who are referred for surgical treatment, but their waiting time is long, i.e. several weeks or months.

There is abundant literature on steroid injections for carpal tunnel syndrome. We provide reviews of only several studies.

Marshall et al., presented results of systematic review of on the efficacy of local steroid injections in carpal tunnel syndrome [14]. They included 12 studies involving altogether 671 participants. Results of this analysis show

that in most studies steroid injection provides greater symptom relief one month after injection, compared to placebo, however this effect was short-living and was not demonstrated beyond one month. Other findings from this study are as follows: steroid injection provides significantly greater clinical improvement than oral corticosteroid for up to three months; steroid injection does not significantly improve clinical outcome compared to either anti-inflammatory treatment and splinting after two months or laser treatment after 6 months; two local corticosteroid injections do not provide significant added clinical benefit compared to one injection [14].

In a more recent study, Ashworth et al. presented results of Cochrane database systematic review of placebo-controlled studies investigating the efficacy of local steroid injections for CTS [15]. The authors found 14 trials with 994 participants. The main conclusion from this analysis is that intracarpal steroid injections are effective for the treatment of mild and moderate CTS with benefits lasting up to six months. Another finding is that this therapy reduces need for surgical treatment of the syndrome up to 12 months. All studies reported a very low risk of serious adverse events [15].

Similar conclusions were presented in study by Yang et al., (2024), who presented results of a systematic review and network meta-analysis of randomized controlled trials on the effectiveness of injection therapy using various injectables for CTS. In the part relating to the use of steroids these authors state that steroid injections are effective in terms of symptom and pain relief as well as functional improvement in the short term (up to 6 months) but not in the long term [13].

Kaile et al., reported results of the study investigating safety of landmark-guided steroid injections with 40 mg triamcinolone for CTS. These authors have encountered only 4 serious complications in 9515 injections. At routine follow-up, 6 weeks after injection 33% patients reported some side effects, the most commonly it was short-lived local pain (13%) which resolved in all cases within 3 weeks. No cases of intraneural injection or tendon rupture occurred. Most adverse effects were transient, only 13 hands exhibited persistent skin depigmentation or subcutaneous atrophy. The authors conclude that landmark-guided intracarpal steroid injection is safe procedure, burdened with a very low risk of complications [16].

CRITICAL COMMENT

Intracarpal steroid injections are commonly used in the treatment of CTS. Although it is well known that it does not provide a permanent cure, many patients are very satisfied with such therapy. It is safe and cheap, unlike other, non-operative treatments, which are usually much more expensive and similarly (or less) effective. The method is safe, both when given with landmark-guided method or with USG guidance. Steroid injection also has diagnostic value: in doubtful cases, significant improvement after steroid injection confirms diagnosis of carpal tunnel syndrome and that surgical treatment should be effective.

SPLINTING

Among the non-operative treatment modalities splinting has emerged as a first-line treatment in mild to moderate CTS [18-23]. Splints are typically recommended for use at night, but may also be worn during daytime hours depending on patient work and activity demands. By maintaining the wrist in a neutral position, splints prevent the extremes of wrist flexion and extension, which have been shown to increase pressure within the carpal tunnel, irritate the median nerve and causes symptoms. Most of splints only immobilize the wrist, but some extend distally and keep the metacarpophalangeal joints extended. This (theoretically) prevents the lumbrical muscles from proximal migration and entering the carpal tunnel. There are many studies in the literature supporting the use of splints in mild to moderate CTS. Older studies reported significant beneficial effect of splinting. Manente et al. (2001) reported significant reduction of nocturnal symptoms (pain and numbness) and functional improvement, after use of a soft hand splint at night for 4 weeks, when compared with a control group [18]. Other studies reported similar benefits from splinting [19-22].

However, an updated meta-analysis of the literature by Karjalainen et al. showed different picture. Results of recent studies showed that night splinting provides little or no benefits in reduction of symptoms in the short term (< 3 months) and does not improve hand function in the short and long term (> 6 months). In the short and long term, the mean BCTQ was 0,24 points better after splinting compared with no active treatment. The Minimal Clinically Important Difference (MCID) for BCTQ is 0,7 points, what means that this improvement was not clinically meaningful. Nevertheless, these variables were better after splinting compared to before treatment [23].

An assessment of efficacy of splinting as an additional treatment to steroid injection, rehabilitation, kinesiology taping, rigid taping or extracorporeal shock wave treatment (ESWT) showed that splinting does not provide additional benefits in reduction of symptoms or improvement of hand function when given together

with these measures. Results of some studies showed that splinting for 12 weeks was not better than 6 weeks, but 6 months of splinting was more beneficial than 6 weeks of splinting in cessation of symptoms and improving of hand function [23].

The evidence whether splinting benefits patients with carpal tunnel syndrome is not clearly convincing. This means possibility of small improvements in symptoms and hand function, but they may not be clinically meaningful. Results of some studies suggest that patients may experience overall improvement with night-time splints comparing to no treatment. As splinting is simple, cheap and safe, even small effects could justify its use, particularly when patients are afraid of more invasive treatments. It is unclear if a splint is optimally worn full time or at night-time only and whether long-term use is better than short-term use, but some evidence suggests that the benefits may manifest in the long term [19, 22].

CRITICAL COMMENT

Splinting is now considered an effective treatment for mild CTS, devoid of adverse effects, although somewhat inconvenient for patients. However, it should be stated that it is a good method only for patients with mild symptoms who do not feel discomfort during the day and without impaired hand function. Such a clinical presentation concerns only about 5% of patients, which is a significant minority. The author's experience shows that night splinting never results in full recovery and almost all patients treated with this method are eventually operated on. Night splinting is also recommended for the waiting time for surgery, which can take up to several months. This allows patients survive the waiting time in greater comfort. An intracarpal steroid injection is similarly effective procedure used in patients who are waiting for surgery and suffer from severe pain.

OHER NON-INVASIVE TREATMENTS.

Other, less commonly used non-invasive treatments will be presented in short paragraphs, below.

LOW-LEVEL LASER THERAPY

The beneficial effect of the low-level laser in CTS is (in theory) achieved through several mechanisms, such as increasing myelin production, anti-inflammatory effects, selective inhibition of nociceptive activation at peripheral nerves, increased ATP production and improvement of blood circulation in the median nerve [24-26]. These mechanisms are also mentioned in other disorders in which the laser is used. The most common treatment protocol involved 5 laser sessions a week for a total of 2-3 weeks. Three or 5 application points over the course of the median nerve at the wrist was the most commonly used action position. Different laser irradiation energy doses were used, from 2,7 to 11 J (Joule) for each point or as total energy from 81 to 300 J for the entire treatment [24, 26].

Results of older studies showed reduction of pain and improvement of hand function in patients who received 2-3 weeks laser therapy, however all these studies were uncontrolled [24, 25]. Li et al., (2016) reported results of a meta-analysis of placebo-controlled studies published in recent years. Results of these studies have shown a short-term (3 months in average) beneficial effects of laser therapy on clinical and electrophysiological parameters in the CTS. These findings, however, were not consistent because of different laser intervention protocols used in these studies. Moreover, the functional mechanism of low-level lasers is not clear, and some studies suggested that laser irradiation did not change the functional properties of peripheral nerves [26]. The fundamental disadvantage of these studies is very short follow-up period. Therefore beneficial effect of laser therapy reported in these studies should be treated with caution as potentially short-lived. The reviewed literature also did not provide any evidence that patients with CTS who underwent laser therapy will avoid surgery in the future.

ULTRASOUND THERAPY

Ultrasound (US) treatment within an intensity range of 0,5 – 2,0 W/cm^2 may have the potential to induce various biophysical effects within tissue. The rationale of using US therapy in carpal tunnel syndrome is based on results of some studies which showed its beneficial effects such as an anti-inflammatory effect, stimulation of nerve regeneration via enhanced blood flow, and membrane permeability, as well as improvement of conduction properties in the nerve. Activation of these mechanisms by US treatment might (in assumption) facilitate recovery from nerve compression [27, 28]. Results of study by Ebenbichler et al., (1998) showed that pulsed ultrasound at frequency of 1MHz, and energy of 1,0 W/cm^2 applied to the palmar side of the wrist over 15 min for ten consecutive days, followed by twice weekly treatments for five additional weeks resulted in cessation of pain and nocturnal paresthesiae, improved sensation in the fingers innervated by the median nerve, increased grip and pinch strength and improved electrophysiological parameters. Treatment effects were observed up to 6 months [27]. However,

no additional placebo-controlled studies were available to support the actual effect of US, with certain studies calling its utility into question [21, 28]. Finally, Page et al., (2013) presented results of Cochrane review of studies presenting results of treatment of carpal tunnel syndrome with ultrasound therapy and concluded that there is only poor quality evidence from very limited data to suggest that therapeutic ultrasound may be more effective than placebo for either short- or long-term symptom improvement in CTS patients. They also stated that is insufficient evidence to support the use of therapeutic ultrasound as a treatment with greater efficacy compared to other conservative treatments, such as splinting, physiotherapy, steroid injections and oral drugs [28].

ACUPUNCTURE

Acupuncture aims to stimulate trigger points along the meridian, a proposed pathway of energy through the body. Meridian is a concept from traditional Chinese medicine. According to this concept, meridians form a system of channels wrapping around the human body. They connect to the organs of the body that play a key role in the production, processing, and transmission of energy called Qi. Optimizing this energy pathway is believed to have beneficial effect in CTS without altering mechanical pressures within the carpal tunnel [21]. The mechanism of action of acupuncture remains unknown, proposed theories include a neuromodulatory effect on pain perception by promoting endogenous central nervous system analgesic production and activating anti-inflammatory pathways [21, 29, 30].

In a recent Cochrane review compiling 12 studies and 869 patients, Choi et al. concluded that acupuncture may have little or no short-term effect on CTS symptoms in comparison with placebo or sham procedures [31]. This was largely attributed to heterogeneity of the studies and the risk of bias. The authors also stated that the adverse effects of acupuncture, such as skin bruising and local pain after needle insertion, are inconsistently reported among trials and must be documented to comprehensively assess risks and benefits prior to recommending treatment [31].

EXTRACORPOREAL SHOCK WAVE THERAPY

Extracorporeal shock wave therapy (ESWT) has been used for the treatment of CTS as a novel and non-invasive method (Fig. 1) [32-35]. The mechanism of action of ESWT in carpal tunnel syndrome is not fully understood; the proposed theories include the anti-inflammatory and neuronal regeneration effects as potential mode of action. The anti-inflammatory effect is similar to observed in other musculoskeletal disorders treated with ESWT. This effect on intracarpal structures can modulate the perineural pressure and promote cessation of CTS symptoms. Second proposed mechanism is induction of peripheral nerve regeneration by accelerating the elimination of the injured axon, increasing Schwann cell proliferation, and increasing axonal regeneration. These mechanisms can have effect on improvement of clinical symptoms and electrophysiologic parameters [32, 33].

Xu et al., reported results of randomised study comparing the effect of ESWT vs steroid injection in mild and moderate carpal tunnel syndrome. At the 3 months follow-up, a statistically significantly greater effect on reduction of symptoms and improvement of function was noted for the ESWT group than for the steroid injection group. For the nerve conduction study, there was a significant improvement in the median nerve sensory nerve action potential distal latency at the 3 months follow-ups for the ESWT group. The authors conclude that ESWT is a useful non-invasive short-term treatment for mild to moderate carpal tunnel syndrome and elicits a better recovery than local steroid injection [33].

Kim et al., presented results of a systematic review and meta-analysis of randomized controlled trials on the effect of ESWT in carpal tunnel syndrome. These authors found 6 studies meeting the requirements for analysis, involving a total of 261 patients. Based on results of this analysis they noted that ESWT treatment improves symptoms, functional outcomes, and electrophysiologic parameters in patients with CTS, however, there was no obvious difference between the efficacies of ESWT and local corticosteroid injection. No serious side effects were reported in all included studies [34].

In contrast, results of recent meta-analysis by Chen et al., (2022) which involved 7 randomized controlled trials with a total of 376 participants showed that at the 3 months follow-up, the ESWT did not demonstrate superior efficacy compared to treatment with night wrist splinting alone. The authors conclude that the therapeutic effect of ESWT is transient and mostly nonsignificant [35].

SHORTVAWE AND ELECTROMAGNETIC DIATHERMY

Diathermy is a therapeutic technique that produces deep heating under the skin, muscles, and joints for therapeutic purposes. It is classified into two types: shortwave and microwave diathermy Recently, an electromagnetic diathermy has been introduced alongside these categories. It is known as capacitive resistive electric transfer and it can be considered as longwave

diathermy, as the wave frequency used is relatively lower than those of shortwave and microwave. The physiological effects of diathermy include an increase in blood perfusion which facilitates tissue healing, a local increase of oxygen and nutrients, improved muscle contraction capacity, and a possible positive change in pain sensation [36, 37]. Beneficial effects of diathermy could also be mediated at a central nervous system. Results of functional MRI studies showed central effects of skin warming, with increased activation of the posterior insula and thalamus of the brain which promoted pain relief in the peripheral body parts [37].

Several studies are available investigating an effect of diathermy in carpal tunnel syndrome.

Incebiyik et al., reported results of a randomized clinical trial involving 31 CTS patients who were assigned randomly to 2 treatment groups: first received a hot pack, shortwave diathermy, nerve and tendon gliding exercises (treatment group) and second which received a hot pack, placebo diathermy, nerve and tendon gliding exercises (control group). The treatment was applied five times weekly for a total of 15 sessions. At the one-month follow-up, improvement (cessation of symptoms, better hand function) was observed in both groups, however only in the treatment group it was statistically significantly better than at baseline [36].

Pollet et a., presented results of a systematic review with meta-analysis on efficacy of electromagnetic diathermy for the treatment of musculoskeletal disorders, including CTS, based on 68 studies included in the analysis. Many pathologies were treated with diathermy against placebo. The analysed studies showed controversial results and most of them did not show significant improvements in the primary outcomes. The authors conclude that results of current evidence does not confirm that diathermy or electromagnetic diathermy can be considered an effective therapy in musculoskeletal disorders, including CTS [37].

NEURAL MOBILIZATION

This method generally consists of techniques termed neural glides, neural flossing or neural stretching.

The main objectives of neural mobilisation is to facilitate the gliding of tendons and nerves within the carpal tunnel in order to maximize nerve and tendon excursion to improve axonal transport and nerve conduction [38-40]. Some joint mobilizations described as transverse and ventral glide on dorsal side of the first carpal row were designed to release carpal tunnel syndrome by increasing cross-sectional area of the carpal tunnel. In addition, soft tissue mobilization aims to reduce pressure on the carpal tunnel syndrome by improving the mobility of the myofascial tissues adjacent to the nerve. For CTS, the nerve gliding exercises are done by alternately flexion and extension of fingers with different wrist positions and forearm in pronation and supination [38, 39]. Tendon gliding exercises are done by alternately flexion and extension of all fingers and thumb in metacarpophalangeal and interphalangeal joints, making hook fist, all finger joints in full flexion and full fist [38, 39].

However, variability of manual techniques, lack of terminology consensus and standardization in the techniques whose aim is to mobilize the nervous system raises doubts the actual effectiveness of these techniques. Moreover, parameters such as the mobilization dosages, the number of joints to be mobilized and the consideration to stabilize or not the wrist joint while performing the gliding mobilization techniques are not uniform throughout the studies. These doubts were highlighted in the study by Page et al. (2012) who conducted a systematic review of studies presenting results of neural mobilization for carpal tunnel syndrome. These authors concluded that there was limited and very low quality evidence of benefit for all of a diverse collection of exercise and mobilisation interventions for carpal tunnel syndrome. In most of reviewed studies nerve mobilization techniques provided short-live improvement and only in mild CTS [40]. Therefore patients who indicate a preference for exercise or mobilisation interventions should be aware of the limited effectiveness of this therapy.

KINESIOTAPING

Kinesiotaping is a therapeutic technique that pulls up the skin and provides a space under the skin, directing connective tissue to the expected area. Application of this measure can control the pulling force to a certain tendon or ligament to avoid further injury, so that spontaneous tissue repair can be facilitated. It has been hypothesized that kinesiotaping application, through neural technique and space correction may be beneficial for patients with mild and moderate carpal tunnel syndrome. Geler Kulcu et al. (2016) reported good outcomes after use of kinesiotaping in 45 patients (65 wrists). The tape was applied at beginning of the week, to stay on for 5 days, with a 2-day rest, for a total of four times. At a final follow-up, pain and paresthesiae significantly reduced and hand function significantly improved as assessed by Numeric Rank Scale and the Boston Carpal Tunnel Questionnaire. The problem with this study is that the authors did not provide the follow-up period, therefore actual effect of this therapy cannot be credibly evaluated [41]. In an another study, a

beneficial effect of kinesiotaping combined with splinting was shown [42]. However, it should be stated that this method, although simple and safe, is not popular as a basic treatment and does not constitute a significant alternative to the previously discussed, much better known techniques.

CONCLUSIONS

The review of non-operative treatments of CTS presented in this paper indicates that each of the presented methods provide only short-live improvement and none of them provides a permanent cure. The multitude of these methods is only a confirmation of this fact. Current scientific evidence on the effectiveness of various CTS treatments indicates that only operative treatment by cutting the flexor retinaculum changes the anatomical relations in the carpal tunnel and ensures a permanent cure. It is obvious that surgery is burdened with a certain risk of complications, but this risk is disproportionately small in relation to the benefits achieved. Therefore, without denying the legitimacy of non-surgical therapies in some patients and in some situations, it must be clearly stated that scientific evidence from reliable scientific publications clearly indicates surgical treatment as ensuring permanent recovery from the disease. Therefore, the statements sometimes found in advertisements of some private clinics that one of the new methods of non-surgical treatment is the same effective as surgery, but without unpleasant adverse effects are unjustified and unfair.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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