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The effectiveness of acupuncture in treating carpal tunnel syndrome: A literature review

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Abstract

Introduction: Carpal Tunnel Syndrome (CTS) is the most common peripheral nerve entrapment neuropathy, significantly affecting upper limb function and work productivity. First described by Paget in 1854, CTS is primarily diagnosed clinically based on symptoms such as numbness and tingling, often worsening at night, and positive provocative tests. Its pathophysiology involves increased pressure within the carpal tunnel, ischemia, inflammation, and genetic predispositions. Treatment options include conservative approaches like splinting and pharmacotherapy, as well as surgical decompression. Recently, minimally invasive methods such as acupuncture have gained attention, particularly in cases where conventional treatments are ineffective.

Aim: This article aims to review the pathophysiology and standard treatments of CTS, with a particular focus on assessing the role and effectiveness of acupuncture as a minimally invasive therapeutic alternative.

Review Methods: A comprehensive literature review was conducted using PubMed and Google Scholar, focusing on the following keywords: acupuncture, carpal tunnel syndrome treatment, and pathophysiology of carpal tunnel syndrome.

Conclusion: Acupuncture-especially manual acupuncture and when combined with other interventions like splinting-shows promise in reducing CTS symptoms and improving functional outcomes. In some cases, it may be more effective than pharmacological treatments. Neuroimaging studies have indicated that acupuncture may trigger objective neurophysiological changes associated with symptom relief. However, the current quality of evidence is generally low or very low, underscoring the need for more rigorous, large-scale randomized controlled trials to better define its efficacy and establish standardized treatment protocol.

Keywords: acupuncture, carpal tunnel syndrome, CTS, treatment, pathophysiology

Introduction

Carpal tunnel syndrome (CTS), the most prevalent peripheral nerve entrapment neuropathy affecting the upper limb, was initially investigated in 1854 by Paget (1). CTS diagnosis is primarily clinical, suspected based on patient-reported typical symptoms like numbness and tingling in the fingers, often worsening at night (1, 2). Patients may experience pain and a sensation of swelling in the hand (1). A characteristic feature is impaired sensation in the thumb and adjacent fingers (2, 3). As the condition progresses, weakened grip strength and thenar muscle atrophy may occur (2, 3). Symptoms often intensify at night or during repetitive hand movements (1, 2). Provocative tests, such as Tinel's sign and Phalen's maneuver, which elicit typical symptoms, are helpful in diagnosis (1, 3). In advanced cases, thenar muscle atrophy may be visible (3). This condition primarily affects middle-aged

women. The prevalence in the general population ranges from 0.125% to 1% and can reach up to 5% among individuals exposed to risk factors. Age demonstrates a strong association with CTS development, with individuals over 55 years being more susceptible (2, 3). Elevated body mass index (BMI) and anthropometric hand measurements also correlate with the occurrence and severity of CTS symptoms (2, 3). Female sex is a significant risk factor, with CTS prevalence being ten times higher in women than in men (2, 3, 4). Certain cardiovascular factors, such as obesity, high cholesterol, hypertension, and cardiac arrhythmias, may be linked to CTS, particularly in younger and older individuals (1). Long-term hypertension can increase the risk of CTS (3). Inherent traits like short stature, obesity, as well as comorbidities including diabetes, hypothyroidism, and rheumatoid arthritis, pregnancy, monotonous wrist activity, and anatomical alterations in the carpal tunnel can contribute to CTS development (2, 3, 5). Inflammatory processes in rheumatoid arthritis increase the risk of CTS (3). Occupational factors, such as repetitive wrist movements, forceful exertion, awkward posture, and vibration exposure, are significant risk factors for occupational CTS (2, 5, 4). Jobs requiring frequent, constrained wrist movements lasting less than 30 seconds or where over 50% of work time involves such movements are considered high risk (4). High movement repetition appears to be a greater risk factor than high force, although both combined significantly elevate the risk (4). Other secondary CTS risk factors include pregnancy, menopause, renal failure, oral contraceptive use, and congestive heart failure, which can increase the volume of the synovial sheath within the tunnel (2, 5). Direct fractures of the distal radius, post-traumatic changes, and tumors can also alter the carpal tunnel anatomy (2, 5). Neuropathic factors, such as diabetes, alcoholism, vitamin toxicity or deficiency, and exposure to toxins, can elicit CTS symptoms independently of increased carpal tunnel pressure (2, 5). Increased thickness and stiffness of the flexor retinaculum (TCL) can reduce carpal tunnel space (2). CTS can be an early indicator of amyloidosis (2). Studies suggest that patient-related (intrinsic) factors may have a greater impact on CTS development than work-related (extrinsic) factors. Tobacco smoking, alcohol abuse, and caffeine consumption may also increase CTS risk (4).

Materials and methods

A thorough review of research articles indexed in PubMed and Google Scholar was conducted, employing search terms that included the following keywords: acupuncture, carpal tunnel syndrome treatment and pathophysiology of carpal tunnel syndrome.

Pathophysiology of carpal tunnel syndrome

Carpal tunnel syndrome occurs due to increased interstitial pressure within the carpal tunnel, ultimately resulting in compression and injury of the median nerve (2, 3). The exact pathophysiological mechanism is not fully understood (1, 2, 3). The prevailing hypothesis suggests that mechanical compression of the median nerve leads to localized ischemia, subsequently causing demyelination of both small and large nerve fibers and evoking characteristic symptoms. Normal pressure within the carpal tunnel ranges from 2 to 10 mmHg. Repetitive wrist movements can induce significant fluctuations in this pressure, with wrist extension potentially increasing it tenfold and flexion eightfold. Local compression initiates nerve demyelination that spreads to internodal segments while axons remain intact (2, 3). Sustained compression impairs blood flow within the endoneurial capillary system, leading to alterations in the blood-nerve barrier and the development of endoneurial edema (2). The rapid resolution of symptoms following surgical decompression supports the theory that mechanical compression induces reversible, localized ischemia. Sensory fibers are typically affected before motor fibers. The elevated pressure within the carpal tunnel can result in compartment syndrome, causing a dramatic reduction in epineurial perfusion and ischemia. This, in turn, leads to neural tissue swelling, further exacerbating nerve conduction delays already caused by demyelination. The reversibility of damage depends on the duration of ischemia; shorter compression periods are readily reversible, whereas longer durations increase the risk of irreversible neural damage. Intraoperative observations often reveal a thinned nerve at the compression site and swelling proximal to the entrapment. This edema is hypothesized to be largely due to axoplasmic buildup and chronic inflammatory fibrotic

processes within the neural tissue. Inflammation frequently arises from increased release of prostaglandin E2 and other pro-angiogenic factors like vascular endothelial growth factor. The ultimate consequences include axonal degeneration and neuritis of the median nerve, resulting in slowed nerve conduction and increased latency (2). Alternative pathogenic theories include microvascular insufficiency and the effects of vibration (1). The microvascular insufficiency theory posits that a lack of blood supply leads to nutrient and oxygen depletion in the nerve, impairing nerve impulse transmission. Scar and fibrous tissue may eventually develop within the nerve (3, 4). Ischemia of the affected nerve segment is considered a primary cause of characteristic CTS symptoms, particularly tingling, numbness, and acute pain, along with acute and reversible nerve conduction impairment. Studies have demonstrated the restoration of normal pulsatile blood flow within the median nerve within one minute of transverse carpal ligament release, suggesting a significant role for ischemia in CTS etiology (1). Elevated carpal tunnel pressure can contribute to ischemia (1, 3). Research has shown increased levels of interleukin-6, malondialdehyde, and prostaglandin E2 in CTS patients, indicating the involvement of oxidative stress. The vibration theory suggests that long-term use of vibrating tools can affect the median nerve within the carpal tunnel, leading to epineurial edema and alterations in axoplasmic structures (1). The carpal tunnel contains tendons and other connective tissue structures. Pathologies of the flexor retinaculum and flexor tendons may also contribute to CTS pathogenesis (3). Nerve entrapment involves a combination of compression and traction, which can cause disorders of intraneural microcirculation, lesions in the myelin sheath and axon, and alterations in supporting connective tissue. Post-operative outcomes suggest that diabetes mellitus can negatively impact recovery after carpal tunnel release, indicating that in diabetic patients, CTS may also stem from intrinsic factors detrimental to the nerve, such as hyperglycemia and deficiency of neurotrophic factors (4). Genetic predispositions to CTS development may arise from polymorphisms in genes related to collagen synthesis and breakdown, as well as genes influencing protection against oxidative stress. Mutations in extracellular matrix (ECM) proteins may also play a role in CTS pathogenesis. Genetic factors are suspected in cases of early CTS onset, familial recurrence, and bilateral symptoms (2).

Treatment

Many treatments for carpal tunnel syndrome have been described, and since so many are commonly used, it's clear that no single treatment stands out as the best.

Two primary treatment approaches exist: conservative and surgical. Non-operative methods frequently alleviate mild to moderate symptoms in the short term. However, surgical intervention is considered when conservative management doesn't provide sustained improvement or when symptoms are severe. The most prevalent surgical procedure involves decompressing the median nerve by dividing the transverse carpal ligament, with the goal of reducing pressure within the carpal tunnel.

Surgical treatment

Surgical treatment for CTS, involving division of the transverse carpal ligament (TCL), is an effective method (1). It can be performed via open (OCTR) or endoscopic (ECTR) techniques, with similar long-term outcomes (1, 3). OCTR is widely accepted and successful (1, 2), indicated for various CTS cases (1). ECTR, though more expensive and with a higher risk of transient nerve damage, is an alternative (1, 3). The overall success rate of surgery is 70-90% (2, 3). Surgery is recommended for severe CTS when conservative treatment fails (2).

Pharmacology

Local corticosteroid injections are a common treatment for mild to moderate CTS, reducing inflammation (1, 2, 4). They provide short-term relief, especially within the first month (1, 2, 3), and can be as effective as surgery in the short term (3). Risks include nerve damage and tendon weakening (1, 3). Temporary pain often occurs after injection (3). Oral steroids and NSAIDs are not recommended (1, 2).

Wrist immobilization

Wrist immobilization in a neutral position using a splint is a commonly employed treatment method for carpal tunnel syndrome (CTS). The splint reduces pressure on the median nerve by maintaining the wrist in a position where the carpal tunnel pressure is at its lowest. It is primarily recommended for use at night or during the day when performing repetitive wrist movements.

Therapeutic exercises

Nerve and tendon gliding exercises represent a more recent approach to managing Carpal Tunnel Syndrome (CTS). A characteristic of CTS is the restricted movement (gliding) of the median nerve within the carpal tunnel. These exercises are designed to enhance the nerve's flexibility and its ability to slide smoothly. Examples of such exercises include finger flicking motions and the alternating bending and straightening of the wrist and fingers. These movements can help stretch the tissues within the carpal tunnel, improve blood flow in the veins, and reduce swelling in the area.

Manual therapy for carpal tunnel syndrome (CTS)

These methods target soft tissues through mobilization and massage, address joints with mobilization and manipulation, and utilize neurodynamic techniques for the nervous system. The goals of manual therapy include reducing forearm tension, enhancing the median nerve's ability to glide within the carpal tunnel during wrist, finger, and elbow movements, and positively affecting both the skeletal and soft tissue structures. Studies indicate that manual therapy can alleviate CTS symptoms and improve physical function. Some research even suggests that in the initial months, manual therapy might provide significant short-term relief, potentially surpassing that of surgery in terms of pain reduction and functional improvement.

Procedure of acupuncture

Originating outside of traditional biomedicine, acupuncture remains a controversial method for treating chronic pain. Its traditional explanations rely on concepts like meridians and the flow of qi energy, which lack confirmation in anatomy and physiology. Although many contemporary practitioners move away from these theories, clear evidence is still lacking on how needling specific points on the body would lead to lasting pain reduction. Undeniably, acupuncture elicits short-term physiological effects, potentially relevant in pain relief; however, the mechanism of their long-term action remains unknown.

Acupuncture in the treatment of carpal tunnel syndrome

Minimally invasive treatment methods, such as acupuncture, may be an effective option in managing carpal tunnel syndrome, especially when surgical and anti-inflammatory treatments do not provide relief (1). Acupuncture appears to have the potential to alleviate symptoms of

carpal tunnel syndrome (1, 2, 3). In particular, manual acupuncture may be more effective in reducing symptoms compared to some medications such as ibuprofen and prednisolone (1).

In a randomized, controlled study, Yang et al. (13) explored the effectiveness of acupuncture compared to steroid treatment for patients with mild-to-moderate carpal tunnel syndrome (CTS). They found that short-term acupuncture was on par with low-dose prednisolone in addressing both objective measures from nerve conduction studies (NCS) and subjective symptoms. This discovery is particularly beneficial for individuals who either cannot tolerate oral steroids or prefer not to pursue early surgery, offering acupuncture as a viable alternative for treatment.

Furthermore, acupuncture, especially when combined with other treatment methods (such as splinting), may yield greater benefits in reducing symptom severity and improving functional status (1, 2).

Wu and colleagues (10) carried out a systematic review of randomized controlled trials. Their findings indicate that manual acupuncture is more effective than ibuprofen for both symptom relief and functional improvement. Additionally, electroacupuncture combined with splinting demonstrates better results than splinting alone. However, evidence supporting the role of electroacupuncture in pain reduction is still limited.

Dong et al. (12) conducted a review of randomized control trials that indicated acupuncture was more effective for pain relief compared to other treatments. However, when compared to night splints, there was no significant difference in symptom severity or functional status. Furthermore, acupuncture did not show a marked advantage over medication in terms of reducing symptom severity or enhancing electrophysiological parameters. As a supplementary therapy, acupuncture may provide benefits for carpal tunnel syndrome (CTS) regarding symptom severity, functional status, pain intensity, and electrophysiological outcomes, proving to be more effective than medication in these areas. The authors emphasize that acupuncture as an adjunctive treatment can be beneficial for CTS patients. They also call for more thorough studies with objective outcomes to further explore the effects of acupuncture compared to sham treatments or other active therapies.

Kumnerddee and Kaewtong (14) conducted a randomized controlled trial to assess efficacy of acupuncture versus night splinting for carpal tunnel syndrome. They examined 61 mild-to-moderate degree CTS patients and shown that electro-acupuncture was as effective as night

splinting in respect of overall symptoms and functions in mild-to-moderate degree CTS. However, pain was reduced more by electro-acupuncture than night splinting.

Tezel and colleagues (15) conducted a similar study, which revealed that the group receiving both acupuncture and splinting experienced a greater reduction in pain levels compared to those receiving only splinting. However, their research did not demonstrate significant differences between the two groups regarding changes in sleep, functional scores, and the physical activity subscale of the NHP score.

Yao and colleagues (16) conducted a study to evaluate how effective acupuncture is compared to anti-inflammatory treatment for patients suffering from carpal tunnel syndrome (CTS). The research involved fifty participants with mild to moderate CTS, who were randomly assigned to two different groups. Both groups were given night wrist splints as part of standard conservative treatment for one month. The group receiving acupuncture underwent eight sessions of therapy, with treatments twice a week for four weeks. Meanwhile, the control group was administered 400 mg of ibuprofen three times daily for ten days. To assess the outcomes, the researchers measured the visual analog scale (VAS) score, the scores from the Boston Carpal Tunnel Questionnaire regarding Functional Status and Symptom Severity (BCTQ FUNCT and SYMPT), and the electrodiagnostic results at the beginning and again one month after treatment. At the final follow-up, both groups showed notable improvements. In particular, the acupuncture group demonstrated statistically significant enhancements in the VAS score and the overall scores on the BCTQ FUNCT and SYMPT, as well as in the electrodiagnostic findings, although there was no significant change in the distal motor latency (DML). These results suggest that acupuncture may offer better benefits in managing the global BCTQ FUNCT and SYMPT scores, the VAS score, and certain electrodiagnostic outcomes compared to ibuprofen, indicating its potential as an effective option for treating CTS.

Chung and colleagues (17) conducted a randomized, parallel-group, assessor-blinded trial with two arms, focusing on patients diagnosed with primary carpal tunnel syndrome. The treatment group received 13 sessions of electroacupuncture over the course of 17 weeks, while the control group consisted of 90 participants treated solely with splinting. For patients experiencing chronic mild to moderate symptoms without surgical intervention, the results indicate that adding electroacupuncture to nocturnal splinting leads to modest improvements in symptoms, disability, functional capabilities, dexterity, and pinch strength.

Neuroimaging studies suggest that true acupuncture elicits objective neurophysiological changes in the brain and nerves, which are associated with improvement (3). At the same time, it should be noted that acupuncture alone is not always superior to other treatment methods in all aspects (2).

Ural and Öztürk (18) aimed to investigate the effects of acupuncture on the cross-sectional area (CSA) of the median nerve at the wrist in patients with carpal tunnel syndrome (CTS). They also sought to determine the relationship between clinical, electrophysiological, and ultrasonographic changes. The study included 27 female patients, who were randomly assigned to either an acupuncture group or a control group, with both groups using a night wrist splint. The acupuncture group received additional acupuncture therapy.Measurements such as the Visual Analog Scale (VAS), Duruöz Hand Index (DHI), and Quick Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire scores, along with electrophysiological assessments and median nerve CSA evaluations, were recorded both before and after treatment for each group.Results revealed improvements in VAS, DHI, Quick DASH scores, and electrophysiological measurements for both groups. However, the CSA of the median nerve showed a significant decrease in the acupuncture group while remaining unchanged in the control group. The findings suggest that patients with CTS may experience both clinical and morphological benefits following acupuncture therapy.

A study conducted by Bahrami-Taghanaki et al. (19) aimed to evaluate the short-term effects of acupuncture versus conventional medical treatment on patients with carpal tunnel syndrome (CTS). The findings revealed that, in comparison to the control group, the intervention group experienced significant improvements in clinical symptoms, including pain, numbness, tingling, and muscular weakness, as measured by the global symptoms score questionnaire. Notably, the electrodiagnostic results showed that the acupuncture group had a marked decrease in distal motor latency compared to the controls. Moreover, all clinical symptoms and electrodiagnostic outcomes exhibited substantial enhancements within the intervention group, with these benefits persisting for three months after the treatment concluded. The therapeutic effects of acupuncture were largely comparable to, and in some instances exceeded, those of traditional medical treatments. Therefore, acupuncture can be considered a safe and effective therapeutic option for individuals with CTS.

Additionally, the certainty of evidence regarding the effectiveness of acupuncture in CTS is often rated as low or very low, highlighting the need for further, more rigorous research (3).

Conclusion

Carpal tunnel syndrome (CTS) is a common compression neuropathy that significantly impacts the function and productivity of the upper extremity. This paper presents a review of the pathophysiology of CTS, traditional treatment methods (surgical and conservative), and focuses on the role of acupuncture as a minimally invasive therapeutic option. Acupuncture, particularly manual acupuncture and when combined with other methods, shows potential in alleviating CTS symptoms and improving functional status, in some cases surpassing the effectiveness of pharmacotherapy. Nevertheless, the current evidence regarding the efficacy of acupuncture in the treatment of CTS is characterized by limited certainty. Therefore, to better understand the role of acupuncture in the therapy of carpal tunnel syndrome and to establish optimal treatment protocols, further rigorous research with larger patient groups, randomization, and control groups is essential.

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