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The Carpal tunnel syndrome - CTS - primary and secondary prevention - review of literature

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Abstract

Carpal Tunnel Syndrome (CTS) is the most common neuropathy affecting the median nerve in the upper limb. It is characterized by pain, numbness, paresthesia, muscle weakness, and difficulties in precise hand movements. CTS can be caused by trauma, excessive nerve stretching, or compression. The condition more frequently affects women, with risk factors including obesity, diabetes, and hypothyroidism. Diagnosis of CTS is based on clinical evaluation, Tinel's and Phalen's tests, and examinations such as EMG or MRI. Treatment includes surgical methods like nerve decompression and conservative approaches such as physiotherapy, kinesitherapy, and neuromobilization. Studies show that tendon and nerve gliding exercises can significantly reduce CTS symptoms. These exercises are less invasive and effective in mild to moderate cases of CTS, providing a good alternative or complement to surgical interventions. Regular stretching and strengthening exercises improve the clinical condition of CTS patients. Findings from the literature review suggest that regular exercise can significantly improve the condition of CTS patients, alleviating pain symptoms and enhancing hand function.

Keywords

fizjoterapia, Carpal tunnel syndrome (CTS), kinezyterapia

Introduction

Carpal Tunnel Syndrome (CTS) is the most common neuropathy of the upper limb, which occurs when the median nerve is compressed as it passes through the carpal tunnel [1, 2]. Carpal Tunnel Syndrome can result from mechanical trauma, excessive stretching, or vascular issues. The underlying pathology of CTS is the compression of the median nerve, leading to nerve ischemia and subsequent impairment of its function. The compression of the median nerve in the carpal tunnel is 2.5 mmHg, and in the case of carpal tunnel syndrome, it can increase to 32 mmHg. Common symptoms include pain, numbness, and paresthesia in the first, second, third, and half of the fourth finger. Muscle atrophy and weakness of the hand, along with limited mobility and difficulty performing precise movements, are also frequently present [2–4]. Women are 2.5 to 4 times more likely to develop carpal tunnel syndrome (CTS) compared to men [4]. Certain health conditions, including obesity, diabetes, and hypothyroidism, double the risk of developing CTS due to increased intraneural pressure in the carpal tunnel or vascular issues [5].

CTS is typically diagnosed based on the evaluation of clinical symptoms, which are verified using Tinel's and Phalen's tests. Routine examinations to confirm CTS include nerve conduction studies, EMG, and MRI, which can be useful in determining the degree of median nerve damage [6]. This analysis of professional medical literature aims to provide an overview of the current knowledge on the effectiveness of CTS treatments, which can be valuable in rehabilitation and encourage further research into optimizing non-invasive treatment methods for this condition.

Materials and Methods

Articles published from January 1, 2014, to May 20, 2024, were found using the free PubMed database with phrases such as "carpal tunnel syndrome treatment effects," "effectiveness of exercises in carpal tunnel syndrome," and "physiotherapeutic interventions in carpal tunnel syndrome." The search results were filtered by selecting criteria such as "systematic review," "randomized controlled trial," "meta-analysis," and "clinical study." The materials were identified independently.

Pathophysiology of Carpal Tunnel Syndrome

From an anatomical perspective, the carpal tunnel is a narrow passage through which the median nerve and nine flexor tendons of the fingers pass [2]. Common causes of compression include inflammation of tendon sheaths, rheumatoid changes, swelling from

injuries, and degenerative processes. Entrapment neuropathy involves both compression and stretching of the nerve, leading to disruptions in intraneural microcirculation, damage to the myelin sheath and axon, and changes in the supportive connective tissue. Peripheral nerve entrapment occurs when the nerve passes through an anatomical canal that becomes too narrow, resulting in changes in nerve function and causing dysfunction or damage at the site of compression and beyond [7,8]. There are three main mechanisms through which increased pressure in the carpal tunnel can occur. The first is compression from the volar (palmar) side of the wrist, often due to hypertrophy of the transverse carpal ligament. The second mechanism involves compression from the dorsal (bony) side of the carpal tunnel, stemming from injuries such as a displaced fracture of the distal radius, displaced fractures of the carpal bones, or dislocations of the carpal bones. The third mechanism includes compression from within the carpal tunnel, due to excessive growth of anatomical structures or the development of pathological structures within the tunnel [8].

Increased pressure within the carpal tunnel leads to disrupted nerve microcirculation, ischemia, impaired nerve conduction, reduced movement dynamics and adhesion of the median nerve, increased vascular permeability of the median nerve, and axoplasmic flow interruption. This results in swelling of the nerve both proximal and distal to the compression site [9].

Treatment Methods for CTS

The methods of treating Carpal Tunnel Syndrome can be divided into surgical and conservative approaches.

Surgical Treatment:

Surgical treatment involves decompression of the median nerve by cutting the transverse carpal ligament. This procedure can be performed using open, endoscopic, or mini-incision techniques [8]. However, surgical intervention is applied when conservative treatment does not yield satisfactory results [10].

Conservative Treatment:

Conservative treatment includes physical therapy (such as energy laser therapy and shockwave therapy), hydrodissection, kinesiology taping, corticosteroid injections, splinting, and the simplest form of conservative treatment - kinesiotherapy [13]. Exercises in carpal tunnel syndrome are often supported by neuromobilization of the median nerve.

Exercises for Carpal Tunnel Syndrome

For carpal tunnel syndrome, various rehabilitative procedures may be recommended. Exercises are the simplest and most cost-effective form of conservative treatment for CTS. Comparing exercises to other treatment methods, it has been found that exercises are less invasive and can be equally effective in mild to moderate cases of CTS. Although surgical interventions may be necessary in severe cases, exercises can serve as a valuable alternative or complement to therapy [5,6,8,10]. Neurodynamic techniques can improve the glide of the median nerve in the carpal tunnel, reducing compression and inflammation [13]. Stretching and strengthening muscles can increase flexibility and muscle strength, which reduces pressure on the nerve. Studies have shown that regular performance of these exercises can significantly improve the clinical condition of patients with CTS [14].

See Figure 1-9 for a sample set of exercises for patients with carpal tunel syndrome.

Discussion

In the scientific review by Genova et al. [1], it is emphasized that prevention is crucial in managing carpal tunnel syndrome (CTS), particularly in occupations that involve repetitive movements. When symptoms occur, treatment typically includes wearing wrist splints, using anti-inflammatory medications, and engaging in physical therapy to strengthen muscles and improve flexibility. Postoperative physical therapy to enhance range of motion, strength, and function is also significant following surgical intervention. Effective management of CTS requires a holistic approach that integrates medical and occupational strategies. When CTS is diagnosed, doctors typically begin with non-surgical therapies. The muscles of the wrist and hand are often weakened and may atrophy due to severe compression of the median nerve, necessitating strengthening and improved tendon gliding [1]. In a study by Łach and Cygańska [13], the effectiveness of preventive exercises for office workers with CTS symptoms was assessed. The exercise group consisted of 49 participants who performed seven planned exercises over eight weeks. The effectiveness was evaluated by measuring hand grip strength, pain scale, CTS symptoms, and hand functional status. Results showed significant differences in right-hand grip strength in the exercise group, with the average increasing from 324.63 N to 338.75 N. No significant changes were observed for the left hand. Pinch grip strength significantly increased for both hands, while no significant changes were observed in the non-exercise group. The exercise group also showed significant improvements in maximum muscle strength during forearm pronation and supination, and

hand flexion and extension, compared to the non-exercise group. Participants in the exercise group reported better functional status of their hand than those in the non-exercise group. Both groups reported a reduction in CTS symptoms in the second and third measurements, but the changes were more pronounced in the exercise group [13].

In a double-blind controlled study on wrist ligament stretching for CTS conducted by Shem et al. [14], 83 participants with median nerve mononeuropathy were divided into a wrist ligament stretching group and a sham treatment group. The experimental group performed self-stretching of the wrist ligament, while the control group performed gentle dorsal wrist massages. Exercises were performed for 30 seconds, four times daily, over six weeks. The analysis revealed no significant differences in wrist and hand pain between the groups, nor any changes over time. However, the treated group showed a significant reduction in numbness and tingling symptoms, which was not observed in the control group. Additionally, pinch strength significantly increased in the treated group, with no changes noted in the control group. Grip strength did not show significant changes in either group. The results suggest that self-stretching of the wrist ligaments may be an effective and convenient therapeutic option for CTS patients, improving numbness, tingling, and pinch strength. This therapy is also more cost-effective and less time-consuming compared to manipulations performed by trained healthcare professionals [14]. In June 2022, a study [15] was published comparing two tendon glide exercise programs as adjunct therapies for CTS. The study aimed to evaluate the effectiveness of neurodynamic technique (NT) versus carpal bone mobilization technique (CBMT) when combined with tendon glide exercises (TGE) in participants with chronic CTS. Participants with unilateral chronic CTS were recruited based on specific criteria and randomly assigned to either the NT or CBMT group, receiving interventions three times a week for three weeks. Pain intensity, symptom severity, functional status, and grip strength were assessed. The results indicate that both NT and CBMT were effective in reducing pain in CTS patients. After three weeks of intervention, pain reduction within the NT group was 69%, compared to 66% in the CBMT group. Between-group analysis showed no significant differences in pain intensity, and these results persisted over four weeks of observation [15]. Won-gyu Yoo examined a 40-year-old man [16] who reported pain, increasing tingling, and numbness in his right hand, particularly during computer work and at night. No muscle weakness or ulnar and radial nerve pathology was found. Tinel's and Phalen's tests were positive. Pain was measured using a pressure dolorimeter. The study included types of three exercises: wrist flexor stretching, wrist extensor stretching, and relaxation exercises. In the first session, the patient performed

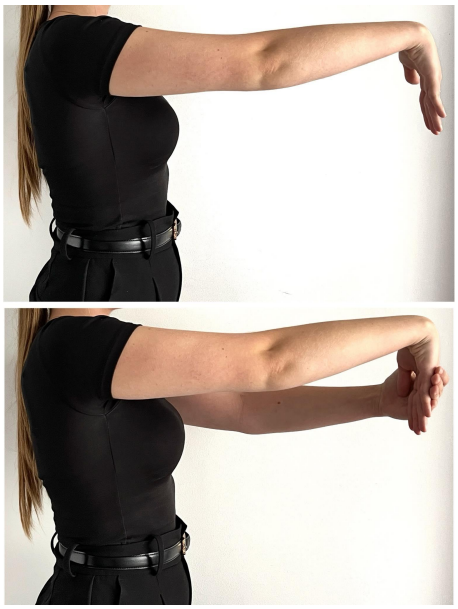
stretching exercises for 60 minutes daily for two weeks. In the second session, relaxing exercises were added, with both stretching and relaxation exercises performed for 60 minutes daily for an additional two weeks. Initially, the pain threshold was 1.3 pounds, Phalen's test was positive 8 out of 10 times, and Tinel's sign was positive 7 out of 10 times. After the first session, the pain threshold increased to 1.5 pounds, Phalen's test was positive 7 out of 10 times, and Tinel's sign remained 7 out of 10 times. After the second session, the pain threshold rose to 2.5 pounds, Phalen's test was positive 4 out of 10 times, and Tinel's sign was positive 3 out of 10 times [16].

Conclusions

The results of the literature review indicate that physical exercises can significantly improve the clinical condition of patients with carpal tunnel syndrome (CTS). Most of the studies analyzed highlight the benefits of regular stretching and strengthening exercises, which help alleviate pain symptoms and enhance hand function.We present an exercise program created for CTS that the patient can perform on his own, both before and after surgical treatment. Good effects of CTS treatment can be achieved through an appropriate, regular program of exercises that strengthen the muscles and improve the stretching of the compressed median nerve. The exercises described in this article are examples. Patients must stay in contact with their doctor or physiotherapist, who work closely together.

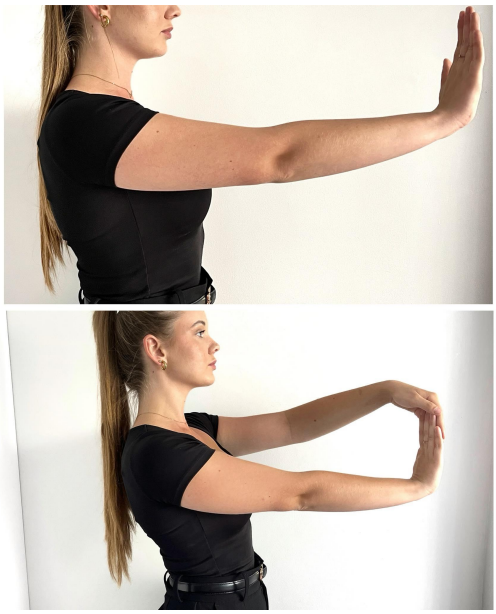
Legend to figures

Figure 1. Exercise 1.



Keeping your arm straight out in front of you with your palm facing down, gently bend your wrist downward. Using your other hand, pull the stretching hand towards your body and hold for 15–30 seconds. Straighten your wrist. Do 2 sets of 5 repetitions for each hand.

Figure 2. Exercise 2.

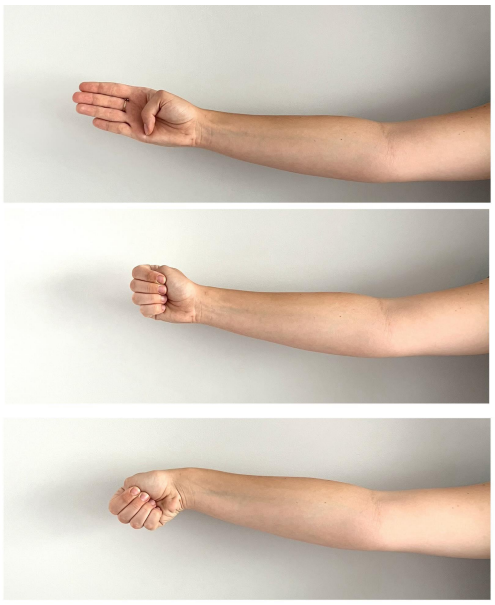


Keeping your arm straight out in front of you, bend your wrist as if making a “stop” sign. Using your other hand, pull the hand towards your body and hold for 15-30 seconds. Straighten your wrist. Do 2 sets of 5 repetitions.

Figure 3. Exercise 3.

Raise your hand in front of you, straightening your fingers. Bend your middle fingers and hold for 5 seconds. Do 3 sets of 10 repetitions for each hand.

Figure 4. Exercise 4.



Clench your fist with your thumb tucked inside the fist. Bend your wrist downward. Return to the starting position. Do 3 sets of 10 repetitions for each hand.

Figure 5. Exercise 5.

Place your hands together in front of your chest at chin height, with elbows at shoulder height. Lower your hands, keeping them close to your body, until you feel a stretch. Hold for 15-30 seconds. Do 2 sets of 5 repetitions.

Figure 6. Exercise 6.

Place your hands together with fingers interlaced in front of your chest and point them downward. Spread your hands apart as far as possible without separating your fingers. Do 2 sets of 10 repetitions.

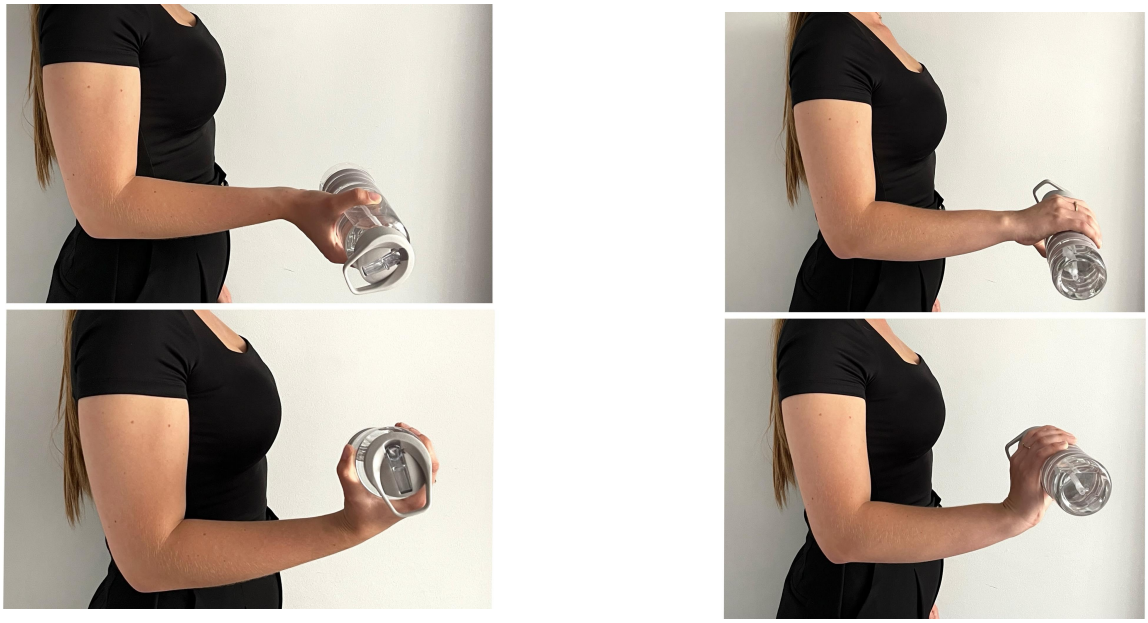
Figure 7. Exercise 7.

Place the backs of your hands together with fingers pointing downward in front of your chest, with elbows at shoulder height. Hold this position for 30 seconds. Do 2 sets of 3 repetitions.

Figure 8. Exercise 8.

Raise your arm at the shoulder joint and bend it at the elbow and wrist. Extend your arm at the elbow joint while simultaneously tilting your head towards the exercised arm. Do 2 sets of 10 repetitions on each side.

Figure 9. Exercise 9.



Take an object in your hand, such as a water bottle. Bend your arm at the elbow to a 90-degree angle, with your forearm in a pronated position. Perform alternating arm flexion movements against resistance. Do 3 sets of 10 repetitition.

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