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VARIOUS NON-SURGICAL THERAPY IN CARPAL TUNNEL SYNDROME THAT CAN BE AN OPTIONAL THERAPY FOR DENTISTS: SCOPING REVIEW

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ABSTRACT

Introduction: *Carpal tunnel syndrome (CTS) is a common condition among dentists due to awkward hand positions, repetitive hand movements, mechanical pressure on the palms, strong grips, and vibration of tools involved in their work. Non-surgical therapy is recommended for mild to moderate levels of CTS, while surgical treatment may be considered for severe cases.* ***Aim:*** *This study aims to determine the effectiveness of various non-surgical therapy for CTS.* ***Method:*** *The literature search used Boolean language in PCC format on PubMed and Google Scholar databases. The literature search was according to PRISMA-ScR flow chart guidelines and 6,641 articles were obtained. 16 articles met the inclusion criteria, consisting of: splinting (n=2), local steroid injection (n=2), median nerve neuromobilisation (n=2), and journals that tested and compared a combination of non-surgical therapies or more than one non-surgical therapy (n=10).* ***Result:*** *This review shows that non-surgical therapies are effective for CTS patients.* ***Conclusion:*** *Various non-surgical treatment for CTS is effective in reducing pain and improving hand functional ability. These therapies can be an optional therapy for dentists with high CTS risk factors.*

Keywords: *Carpal tunnel syndrome (CTS), effectiveness, non-surgical treatment*

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INTRODUCTION

Carpal tunnel syndrome (CTS) can be triggered by various risk factors, including repetitive movements, awkward postures, temperature, mechanical stress, strong exertion, and vibration from dental instruments during dental work. Holding dental instruments in an inappropriate position for an extended period can put pressure on the carpal tunnel and can cause CTS in dentists.[1,2] Musculoskeletal disorders in dentists, including CTS can lead to decreased work productivity, reduced quality of life, increased health costs, and early retirement.[3,4]

CTS is a medical condition that occurs when the median nerve is compressed due to the narrowing of the carpal tunnel in the wrist. This compression leads to numbness, pain, and tingling in the wrist.[5] The carpal tunnel is a narrow passage in the central part of the wrist that is formed by bones and ligaments and is traversed by the median nerve and tendons. The carpal tunnel is formed by the carpal bones on the base and sides, and the flexor retinaculum (transverse carpal ligament and palmar carpal ligament) on the roof.[6] Inside the carpal tunnel, there is the median nerve, which consists of ulnar and radial branching. The median nerve's radial branches provide sensory innervation to the palmar surface of the first and second fingers, as well as motor innervation to the opponens pollicis muscle, the upper part of the flexor pollicis brevis muscle, and the abductor pollicis brevis muscle. In contrast, the ulnar branch of the median nerve provides sensory innervation to the surfaces of the second, third, and radial sides of the fourth finger. Furthermore, the median nerve innervates the dorsal surfaces of the second, third, and fourth fingers distal to the proximal interphalangeal joint.[7] Additionally, the carpal tunnel contains several tendons responsible for finger movement.[6]

The management of CTS is divided into two categories: non-surgical and surgical therapy. Non-surgical therapy is recommended for patients with mild to moderate CTS and intermittent symptoms. Meanwhile, patients with severe CTS with continuous symptoms, severe sensory disturbances, and/or thenar muscle motor weakness can be considered for surgical therapy. Medicamentous therapy and non-medicamentous therapy are the two forms of non-surgical therapy. Medicamentous therapy can include steroid injections, analgesics, topical anesthetic agents, oral steroids, gabapentin, diuretic agents, pyridoxine (vitamin B6), vitamin D, and other drugs.[5,8] Meanwhile, non-medicamentous therapy can include the use of splints, lifestyle modification, manual therapy, laser, yoga, ultrasound therapy, nerve/tendon gliding exercise, exercise therapy, and acupuncture.[8] This scoping review aims to determine the effectiveness of non-surgical therapies for CTS patients.

METHODS

The type of this study is a scoping review guided by PRISMA-ScR. Data mining from PubMed and Google Scholar databases was carried out on 15 August 2023. Data mining was only conducted on the two most easily accessible and free databases. The selection of these two databases is also supported by research from Shariff ZS et.al., wherein the background of this study, doctors often search for information in the Pubmed database to find patient care information. In addition, they also often search the Google Scholar database which has gained popularity because of its free access. The results of the study showed a comparison of relevant article searches between Pubmed and Google Scholar, on Google Scholar is twice as much with much greater access to obtain full and free article texts compared to Pubmed. The conclusion of the study, Google Scholar provides information about citations so that for fast clinical searches, Google Scholar can be relied on.[9,10]

In the literature search, the PCC method was used, namely population: CTS patients who undergo non-surgical therapy, concept: measuring the effectiveness of non-surgical therapy which includes medicamentous therapy (steroid injections, topical anesthetic agents, oral steroids, gabapentin, diuretic agents, pyridoxine) and nonmedicamentous therapy (splinting, lifestyle modification, manual therapy, laser, yoga, ultrasound therapy, nerve/tendon gliding exercise, acupuncture), context: non-surgical therapy in the treatment of CTS patients. The inclusion criteria in this study are journals with research types that use methods such as RCT (randomized control clinical trial), case reports, and clinical trials, journals that discuss non-surgical therapy in the form of medicamentous therapy and nonmedicamentous therapy, as well as journals with research subjects in the form of CTS patients aged 18-60 years. The study also includes journals that use English and Indonesian, with publication years ranging from 2013-2023, and that can be accessed in full text. The Boolean sentences used for data mining in the Pubmed database are: (“carpal tunnel syndrome” OR CTS) AND (“conservative treatment” OR “nonsurgical treatment” OR “non-surgical treatment”) AND (effectiveness OR effect OR effectivity). Google Scholar includes (“carpal tunnel syndrome” OR CTS) AND (“conservative treatment” OR “nonsurgical treatment” OR “non-surgical treatment”) AND (effectiveness OR effect OR effectivity), for Indonesian article mining, the search terms are (“sindrom terowongan karpal” OR “sindrom lorong karpal”) AND (“terapi konservatif” OR “terapi nonbedah”) AND efektivitas.

RESULT

At the identification stage, 6,583 articles were retrieved from the Google Scholar database and 58 articles from the PubMed database, giving a total of 6,641 articles. These articles were transferred to Mendeley software to manage and check for duplicates. 91 duplicate articles were found, which were immediately excluded, and the remaining 6,550 articles proceeded to the screening stage. At the screening stage, the articles were screened again using the information contained in the title and abstract, which were linked to the inclusion and exclusion criteria and the PCC. The results of the screening process revealed that 6,463 articles were excluded, while 87 articles were advanced to the eligibility stage. These articles were assessed for eligibility by a thorough review of their content and a comparison with the established inclusion and exclusion criteria, as well as the PCC.At this stage, 71 articles were excluded for the following reasons: 42 articles had research subjects that did not meet the age inclusion criteria; 25 articles were paid or could not be accessed in full text; 1 article had a research design that was different from the inclusion criteria; 2 articles had language that did not meet the inclusion criteria; and 1 article described a type of non-surgical therapy that did not meet the inclusion criteria. The final selection of journals for inclusion in this study (n=16 articles) was based on the established inclusion criteria (see Table 1). The research flowchart can be seen in Figure 1.

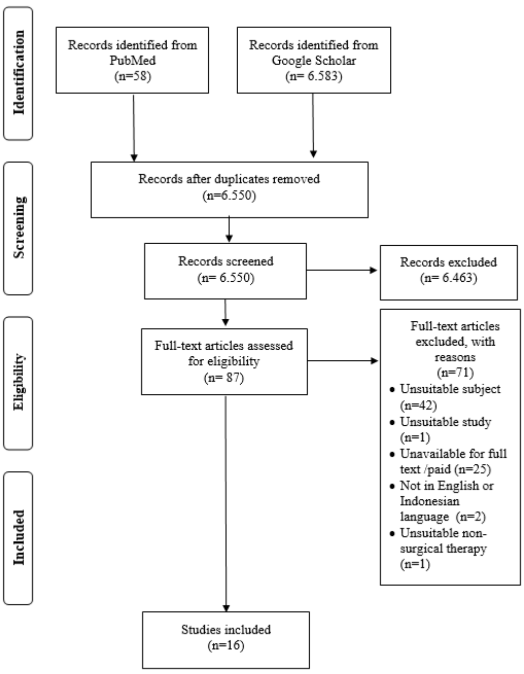

Figure 1. PRISMA flow diagram (study selection process)

DISCUSSION

Research shows that dentists are at a high risk of developing CTS due to the pressure that arises from repetitive wrist movements. This pressure can cause inflammation of the tendons, resulting in pressure on the median nerve.[11] Work that requires strength, repetitive movements, use of hand-operated tools and produces vibrations, long work duration, excess body mass index, non-ergonomic posture, and aggravated by less rest and exercise time can increase the likelihood of CTS in dentists.[11–13]

Occupational MSDs are prevalent among dentists, with a range of 64% to 93%. Meanwhile, the prevalence of CTS in dentists in general ranges from 10.3% to 86%, which increases with increasing working week and age.[11] Several studies of the prevalence of CTS in dentists in the world, show America (56%), Australia (11%), Iran (17%), Riyadh (30.5%)[12], Malaysia (21.2%)[14], Pakistan (10.3%)[15], and Saudi Arabia (9%).[11] For the treatment of CTS, non-surgical therapy is the primary recommendation, followed by surgical therapy if non-surgical therapy is unsuccessful.[16] Non-surgical therapy is recommended especially in mild to moderate cases of CTS.[17]

This scoping review presents 19 journals that describe the effectiveness of non-surgical therapies for CTS patients. The journals included are from different countries including Pakistan;[18–21] Iran,[22–25] Saudi Arabia,[26–29] Egypt;[30] Iraq[31] and India.[32,33] There were 5 studies that tested the effectiveness of splinting. [21,25,26,29,33] Splinting showed significant pain and pain threshold improvement.[21,29] Another study that combined splinting with ultrasound resulted in better pain reduction as ultrasound stimulates regeneration which aids in the healing of the median nerve.[26] A study that combined splinting with the scaphoid and hamate mobilization resulted in greater improvements in pain, symptom severity, and functional ability because scaphoid and hamate mobilization reduced pressure on the median nerve, reduced intra-neural edema, and improved blood supply.[25] A study comparing splinting with nerve and tendon gliding exercises found that both interventions reduced pain.

However, nerve and tendon gliding exercises resulted in a more significant improvement in functional ability because they can stretch the carpal ligament, reducing pressure on the median nerve and improving blood flow out of the carpal tunnel, which reduces fluid pressure in the tissue.[33] Splinting was effective as a CTS treatment in these studies because it works by reducing wrist flexion, which reduces carpal tunnel pressure and median nerve compression.[21]

There were 3 trials that tested the effectiveness of local steroid injections.[22,31,32] The administration of a local steroid injection has been shown to significantly improve pain intensity, symptom severity, and functional ability.[32] Additionally, a separate study found that electrophysiological parameters experienced a temporary improvement in the first month post-injection due to the anti-inflammatory and anti-edema effects of steroids. However, electro-physiological parameters deteriorated in the sixth month due to the discontinuation of steroid injection. This caused a decrease in vascularisation around the median nerve, which led to vascular congestion and enlargement of the median nerve, resulting in the recurrence of CTS.[31] A separate study comparing local steroid injection with wrist mobilization demonstrated improvements in electro-diagnostic, pain intensity, symptom severity, and functional ability for both interventions, with no significant difference between the two. Wrist mobilization reduces pressure and edema, normalizes blood flow, and improves median nerve conduction.

This scoping review analyzed 3 studies that compared the effectiveness of low-level light therapy (LLLT) with ultrasound.[24,28,30] The results showed that both LLLT and ultrasound produced improvements in nerve conduction studies (NCS) results, pain, grip strength, and pinch strength, and there was no significant difference between the two interventions.[30] Another study demonstrated that LLLT and ultrasound significantly improved pain and functional ability in mild CTS participants. In participants with moderate CTS, it was found that LLLT led to a more significant reduction in pain due to its superior inflammatory and proliferative phase response. Meanwhile, ultrasound led to a more significant improvement in functional ability among moderate CTS participants. This was due to its ability to reduce adhesion between the tendon and median nerve, decrease inflammation, increase synovial fluid for joint motion, and improve tissue flexibility.[28] A separate study compared the effectiveness of combining LLLT and ultrasound with LLLT alone and ultrasound alone. All three interventions resulted in improvements in symptom severity, functional ability, pain, grip strength, and pinch strength. No significant difference was found among the three groups due to the small sample size of the study and lack of follow-up.[24]

This review identified 4 studies that examined the effectiveness of neuro-mobilisation.[18–20,23] The studies found that combining neuromobilisation with physical therapy resulted in significant improvements in range of motion, flexion, extension, pain, symptom severity, and functional ability. Neuromobilisation involves voluntary and passive movements by moving the hand in and out at the maximum range of motion that restores mechanical and physiological nerve function during hand movement, leading to normal function.[18,19] A study comparing neuromobilisation with mechanical interface demonstrated improvements in pain, symptom severity, functional ability, and distal motor and sensory latency of the median nerve in both interventions. No significant difference was found between the two. Manual therapy, such as neuromobilisation and mechanical interface, aims to increase blood flow, reduce pressure around the median nerve, alleviate mechanical irritation, and decrease tissue edema to minimize nerve hypoxia and pain.[23] A comparison study between neuromobilisation and ultrasound demonstrated significant pain improvement in both interventions. However, neuromobilisation resulted in more significant improvements in pain and functional ability than ultrasound.[20]

This scoping review identified one study that tested the effectiveness of neurodynamics.[26] The studies that combined neurodynamic, ultrasound, and splinting showed significant improvements in functional ability and pain. The sliding technique in neurodynamics improves blood circulation, axon transport, and nerve integrity, and reduces pressure due to intraneural and extraneural fibrosis. Meanwhile, the tensioning technique in neurodynamics improves the mechanical function of the nerve by enhancing its flexibility to withstand tension loads without causing tissue hypoxia. A comparison study between neurodynamic and carpal bone mobilization demonstrated improvements in grip strength and pain in both interventions. Neurodynamics demonstrated more significant improvements in nerve conduction velocity, functional ability, and symptom severity by releasing adhesions and nerve entrapment along the upper limb nerve pathway.[34]

CONCLUSION

Various non-surgical therapies are the recommended first-line treatment for CTS due to their proven effectiveness. Non-surgical therapies reduce pain, improve electrophysiologist parameters, increases hand function, reduce symptom severity, and enhances quality of life. Therefore, these therapies can be an optional therapy for dentists with high CTS risk factors.

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Table 1. Overview of included studies

No.	References	Country	Study Design	Subject Criteria	Type of Treatment	Outcome
1.	Ijaz *et al.* (2022)	Pakistan	Prospective, single-blinded randomized clinical controlled trial	Female/male (20-45 years)	Ultrasound; splinting; tendon gliding exercise; neuromobilization	Improved flexion, extension, and decreased symptom severity at the wrist.
2.	Ijaz *et al.* (2022)	Pakistan	Prospective, double-blind randomised controlled trial	Female/male (20-45 years)	Ultrasound; splinting; tendon gliding exercises; neuromobilization	Symptom reduction and improvement in wrist function.
3.	Mohammadabadi *et al.* (2018)	Iran	Prospective, single- blind clinical trial	Female (30-60 years)	Local steroid injection; wrist mobilization; gabapentin; vitamin B6; splint	Electrodiagnostic improvement, increased wrist function, reduced pain intensity, and decreased symptom severity.
4.	Al-Muhanna *et al.* (2015)	Saudi Arabia	Quasi experimental comparative design	Female (30-45 years)	Splint	Improvement in pain threshold.
5.	Ahmed *et al.* (2017)	Egypt	Open label comparative prospective study	Female/male (25-55 years)	LLLT; ultrasound	Improvement of all evaluation parameters.
6.	Alam *et al.* (2018)	Pakistan	Randomized controlled trial	Female/male (30-50 years)	Neural mobilisation; ultrasound	Decreased pain intensity and improved wrist functional ability.
7.	Talebi *et al.*(2020)	Iran	Randomized clinical trial with a two- group parallel design	Female/male (30-50 years)	Mechanical interface; neural mobilisation	Improved wrist functional ability and decreased symptoms and pain.
8.	Mahmoud *et al.* (2016)	Saudi Arabia	Randomized controlled trial (RCT)	Male (40-50 years)	LLLT; ultrasound	Decreased pain and improved functional ability of the wrist.
9.	Sheereen *et al.* (2022)	Saudi Arabia	Two-arm parallel- group randomized comparative design	Female/male (30-59 years)	Neurodynamic; carpal bone mobilization; tendon gliding exercises	Decreased pain and increased grip strength.
10.	Asadi *et al.* (2021)	Iran	Single-blind clinical trial	Female/male (20-60 years)	Ultrasound; LLLT	Reduce pain and improve functional ability of the hand.
11.	Al-Muhanna *et al.* (2015)	Saudi Arabia	Quasi experimental	Female (30-45 years)	Ultrasound; splinting	Reduced pain.

12.	Dinarvand *et al.* (2017)	Iran	Randomized clinical trial	Female (35-60 years)	Splinting; scaphoideum and hamatum bone mobilization	Decreased pain, decreased symptom severity, improved wrist functional ability, and improved nerve conduction studies (NCS) results.
13.	Sabaawi *et al.* (2013)	Iraq	Prospective clinical trial	Female/male (20-55 years)	Local steroid injection	Transient improvement in electrophysiological parameters 1 month post intervention, but worsening 6 months later.
14.	Jain *et al.* (2023)	India	Randomized controlled trial (RCT)	Female (25-30 years)	Splint; nerve tendon gliding exercises; exercise therapy	Decreased pain and improved functional ability of the wrist
15.	Rathoor *et al.* (2023)	India	Double-blinded, single centre, prospective randomised controlled trial	Female/male (20-60 years)	Perineural steroid injection	Reduces pain, symptoms, and improves hand function.
16.	Ali *et al.* (2022)	Pakistan	Quasi experimental study	Female/male (20-60 years)	Splinting	Reduced pain