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The effect of laser and therapeutic ultrasound on the treatment of symptoms of carpal tunnel syndrome: A narrative review

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Abstract
Carpal tunnel syndrome (CTS) is a peripheral neuropathy characterized by pain, numbness, and paresthesia. These symptoms usually occur on the thumb, index, middle and ring fingers. The syndrome is caused by compression of the median nerve as it crosses the wrist through the carpal tunnel. Physiotherapy is able to help patients with CTS in many cases. In recent years, the use of laser and therapeutic ultrasound has become increasingly popular in the treatment of CTS. The aim of this study is to review the latest research data and evaluate the effect of laser and therapeutic ultrasound, but also to compare the treatment methods with each other to find which of the two is more useful. Literature search was performed on the PubMed, PEDro (Physiotherapy Evidence Database) and Google Scholar databases. The keywords used are: carpal tunnel syndrome, laser, Ultrasound. Furthermore, appropriate criteria were applied in the search, such as language and time restriction. This review included 10 clinical studies. The literature review led to the conclusion that the application of laser and therapeutic ultrasound helps to treat the symptoms of the syndrome to a great extent. With proper application the results they offer can remain for many weeks after the end of treatment. Between the two, therapeutic ultrasound seems to be the best method of treatment, however, more studies are needed to draw a safe conclusion.

Keywords: Carpal tunnel syndrome, laser, ultrasound, Physiotherapy

Introduction
Carpal tunnel syndrome (CTS) is a peripheral neuropathy caused by compression of the median nerve as it crosses the carpal tunnel [1, 2]. It is the most common peripheral neuropathy, accounting for 90% of all neuropathies [3]. The first symptoms of CTS include pain, numbness and paresthesia. These symptoms usually occur, with some variability, in the thumb, index, middle fingers and the lumbar region (thumb side) of the ring finger. The pain can also transmit to the affected forearm. As the syndrome progresses, weakness of the hands, decreased coordination in fine movements, Indexterity and later atrophy may occur [4]. CTS is caused by increased pressure in the carpal tunnel and subsequent compression of the median nerve. The most common causes of carpal tunnel syndrome are genetic predisposition, a history of repetitive wrist movements such as typing or manual work, obesity, autoimmune disorders such as rheumatoid arthritis and pregnancy [5].
CTS is estimated to affect one in 10 people during their lifetime and is the most common compression neuropathy syndrome. It accounts for about 90% of all nerve compression syndromes [6]. Its prevalence in the general adult population ranges from 2.7-5.8%. The prevalence of bilateral symptoms is uncertain; however, it is estimated at 50% of cases [7]. Women suffer from the syndrome in a ratio of 3:1 between the ages of 45-60. Only 10% of the reported cases are younger than 30 years. Aging is a risk factor, as is pregnancy [6]. Since 2010, 8% of workers in the USA have reported CTS and 4% have reported CTS in the last 12 months [8].
Physiotherapy is able to help patients with CTS in many cases. It can both help to improve CTS symptoms as well as resolve the cause of the syndrome. Physiotherapy intervention can include special exercises, mobilizations, ergonomic interventions and advice for dealing with

the causes and symptoms, but also electrotherapy tools and generally natural means, mainly for the treatment and improvement of symptoms. In recent years, there has been an increasing use of laser and therapeutic ultrasound in the treatment of CTS. At the same time, the clinical trials where these interventions are evaluated and assessed are increasing [9]. The purpose of this study is to evaluate the effect of laser and therapeutic ultrasound individually, but also to compare these therapeutic interventions with each other to find which of the two offers more benefits.

Method: The literature search was performed on the databases PubMed, PEDro (Physiotherapy Evidence Database) and Google Scholar. Scientific publications were searched using the following keywords: carpal tunnel syndrome, laser, Ultrasound. In order to increase the search scope, synonyms were used as well as Boolean operators such as 'AND' and 'OR' (e.g., Carpal tunnel syndrome AND ultrasound). Appropriate criteria were also applied to the search, such as language and time constraints, excluding studies that have not been translated into English, or were published outside the time frame of 2004-2021. All selected articles were clinical trials.

Table 1: Main characteristics of included studies

Author, Year	Number of participants	Intervention duration	Intervention	Conclusions
Juan *et al*., 2019	n = 84	4 weeks	Group 1: Laser application Group 2: Placebo therapy	Laser application offered a significant reduction in symptoms compared to placebo treatment.
Fusakul *et al*., 2014	n = 66	5 weeks	Group 1: Laser application Group 2: Placebo therapy	The laser reduced symptoms and improved function.
Tascioglu *et al*., 2012	n = 60	3 weeks	Laser application with different parameters in two groups and placebo treatment in the control group.	There were no differences between the groups. Reduction of symptoms was observed in all groups.
Soltani *et al*., 2013	n = 38	8 weeks	Laser application in comparison with cortisone injections.	Improvement of symptoms in both groups without differences between them.
Irvine *et al*., 2004	n = 15	5 weeks	Group 1: Laser application Group 2: Placebo therapy	Reduction of the severity of symptoms in both groups without significant differences between the groups.
Paoloni *et al*., 2015	n = 25	4 weeks	Therapeutic ultrasound in comparison with cryo-ultrasound and shockwaves.	Improvement of symptoms and functioning in all groups.
Jarvik *et al*., 2009	n = 116	6 weeks	Therapeutic ultrasound (in 15 patients) in comparison with surgical treatment.	Both interventions led to a reduction in symptoms. The surgical intervention provided more significant results.
Chang *et al*., 2014	n = 60	8 weeks	Therapeutic ultrasound in comparison with paraffin.	Therapeutic ultrasound had more significant effects than paraffin in reducing symptoms and improving functioning.
Bilgici *et al*., 2010	n = 34	4 weeks	Therapeutic ultrasound in comparison with local steroid injections.	Better results in the group that received therapeutic ultrasound.
Jothi *et al*., 2019	n = 40	7 weeks	Group 1: Therapeutic ultrasound Group 2: Placebo therapy	There were no differences in the results between the two groups. There was improvement in both groups.

Literature review

Juan *et al*. [10] studied the effect of laser on the treatment of symptoms in patients with CTS. The clinical trial included 84 patients, who were divided into two groups. The intervention group of 43 patients followed a protocol using laser for four weeks, with a treatment frequency of five times a week. The control group of 41 participants followed a placebo program with the same duration and frequency without the laser machine being activated. The functional status was evaluated before and after the intervention with the Boston Carpal Tunnel Questionnaire (BCTQ). At the end of four weeks the intervention group had a statistically significant reduction in the severity of symptoms compared to the control group.

Fusakul *et al*. [11] studied the effect of laser on patients with CTS to observe its benefits in treating symptoms. A total of 66 patients participated in this clinical trial. The patients were divided into two groups, where in one a normal protocol was performed using a laser, while in the other the machine was not activated. At baseline and at the 12-week follow-up the following were evaluated: Pain with the visual analog scale (VAS), symptom severity with the Symptom Severity Scale (SSS), disability through the Functional Status Scale (FSS), hand strength through pinch strength, grip strength and electro neurophysiological parameters. The protocol had a duration of five weeks with a total of 15 sessions. After a test performed in the 5th and 12th week, a statistically significant reduction in symptoms and an improvement in hand functioning were observed in the intervention group compared to the placebo group.

In 2012, Tascioglu *et al*. [12] also investigated the effect of laser on people with CTS. The 60 participants were divided into three groups; the first two were treated with laser application of different intensity, while the third group was the placebo group with no laser applied. A total of five sessions were held in a period of three weeks. The pain intensity, grip strength, SSS and FSS values and ultrasonography of the median nerve were evaluated before and after the intervention. There was no statistically significant difference between the three groups. In conclusion, laser application had no benefit in CTS in this clinical trial.

In another study, Soltani *et al*. [13] studied the effect of laser on CTS in 38 patients. Participants were divided into two groups with one group receiving cortisone injections, while the other received a laser protocol. The ability of these interventions to treat the symptoms was assessed. The treatment lasted two months and the patients were followed for another two months after the end of the treatments. Pain with VAS and sensory disorders through electrophysiological findings were evaluated before and after the intervention. The results showed that there was an improvement in symptoms in

both groups without any significant difference between them. The researchers concluded that the laser is an important treatment for the short-term treatment of CTS symptoms.

Furthermore, Irvine *et al*. [14] investigated the effectiveness of laser application in patients with CTS for the treatment of symptoms. The 15 participants were divided into two groups. The intervention group which received the treatment normally consisted of 7 people, whereas the control group which received placebo treatment consisted of 8 people. The study involved three sessions per week for five weeks. The evaluation of the symptoms was performed with a questionnaire and it was observed that there was a great improvement in both groups. There was no difference between the two groups, concluding that laser treatment is not helpful.

Regarding other types of treatment, Paoloni *et al*. [15] studied the effect of therapeutic ultrasound in the treatment of CTS and compared it with other therapeutic methods. A total of 25 patients participated in the clinical study with 42 wrists being evaluated, as some of the patients were affected in both sides. Patients were divided into three groups. In the first group therapeutic ultrasound was applied, while in the second group the treatment consisted of cryo-ultrasound and the third received shockwave therapy. The treatment had a duration of four weeks and with a 12-week follow-up after the end of treatment. Paresthesia with the VAS and symptom severity with the BCTQ were evaluated before and after the intervention. Significant improvement was observed in all groups in terms of symptoms and functioning at the end of treatment and at the follow-up.

The study of Jarvik *et al*. [16] was also focused on the effect of therapeutic ultrasound in the treatment of symptoms of CTS. Their clinical trial involved 116 participants divided into two groups. The intervention group followed conventional therapy and consisted of 59 patients (therapeutic ultrasound was applied to 15 of them), while the control group that was treated surgically consisted of 57 patients. Functioning and severity of symptoms were assessed 12 months after intervention using the Carpal Tunnel Syndrome Assessment Questionnaire. Improvement in function and reduction of symptoms were observed in both groups; however, there were more significant differences in the group that underwent surgical intervention.

Chang *et al*. [17] studied the efficacy of therapeutic ultrasound in relation to paraffin in the treatment of CTS in 60 patients. Patients were divided into two groups who received their treatments with the same frequency (two times a week) and treatment duration (eight weeks). Patients were assessed with a questionnaire, but also with a clinical evaluation at the beginning and at the end of treatment. The BCTQ, pain scale, physical examinations and Nerve Conduction Studies (NCSs) were evaluated before and after the intervention. The results showed that the application of therapeutic ultrasound has a better effect on the treatment of symptoms than the use of paraffin.

Another study that focused on the efficacy of therapeutic ultrasound regarding CTS, was that of Bilgici *et al*. [18]. A total of 34 patients participated in the clinical trial with 49 wrists evaluated as some of the patients were affected bilaterally. The patients were divided into two groups, with in the first one receiving a therapeutic ultrasound protocol and the second one being treated with local steroid injections. Pain with VAS, functioning with FSS, grip strength and two-point discrimination were evaluated at the start of the intervention and at the 4- and 8-week follow-ups. At the end of eight weeks, a significant improvement was observed in all parameters in both groups, but there were better results in the group that received the therapeutic ultrasound.

Lastly, in 2019 Jothi *et al*. [19] studied the effect of therapeutic ultrasound in the treatment of symptoms of CTS. Their study involved 40 patients who were divided into two groups. The intervention group received a normal protocol of therapeutic ultrasound, while the control group received placebo treatment (i.e., the machine was not activated during use). Patients were evaluated 6 and 12 months after the end of the intervention. The BCTQ was used to derive the results and no difference was observed between the two groups, so in this study the therapeutic ultrasound did not offer benefits.

Discussion and Results

From the review and analysis of the results we concluded that laser and therapeutic ultrasound are important physiotherapy methods to combat impairments such as CTS. Based on the clinical trials that evaluated the effect of the laser, we observed that three out of five [10, 11, 13] clinical trials found that there is a reduction in symptoms, while in two of them [12, 14] the laser had no beneficial properties. According to these studies, the laser should be applied 3-5 times a week for 4-6 weeks. The application can be done in consecutive days regardless of the clinical picture of the patient. Regarding therapeutic ultrasound, four out of five [15, 16, 17, 18] clinical trials reported that it had very good results in combating the symptoms of the syndrome. Ultrasound should be performed for 4-8 weeks with at least two sessions per week. The results offered by therapeutic ultrasound remain for 12 weeks after the end of the intervention or even longer in some cases, such as six or 12 months. Ultrasound can be applied at any stage of CTS, either acute or chronic, but as observed in the study of Jarvik *et al*. [16], in severe cases surgical treatment offers better results. When comparing the two treatment methods, therapeutic ultrasound was found to be more beneficial, as it was found ineffective in only one study compared to laser that was ineffective in two studies. It is important to note that the small number of studies included in this review cannot lead to absolute conclusions. More clinical trials should be conducted in the future to draw safer conclusions.

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