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The Effectiveness of Ultrasound and Exercise Therapy in Pain Management and Muscle Strength Optimisation in Cases of Carpal Tunnel Syndrome (CTS) Dextra: A Case Report

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ABSTRACT

Background:
Carpal Tunnel Syndrome (CTS) is one of the most common compressive neuropathies caused by compression of the median nerve in the carpal tunnel. This condition causes pain, numbness, muscle weakness, and reduced functional ability of the hand. Physiotherapy plays an important role in conservative management use modalities such as ultrasound and therapeutic exercises.
Objective:
To determine the effectiveness of ultrasound therapy and exercise therapy in reducing pain and optimising muscle strength in cases of CTS Dextra.
Methods:
A 42-year-old woman presented with complaints of pain and numbness in the right wrist, radiating to the thumb and index finger, accompanied by weakness when gripping. The intervention consisted of ultrasound and exercise therapy (neural mobilisation and joint mobilisation) twice a week for two weeks. Evaluation was conducted using the NRS for pain and the MMT for muscle strength.
Results:
There was a significant reduction in pain across all pain categories. Muscle strength improved in radial and ulnar deviation movements, while flexion and extension did not show changes.
Conclusion:
Ultrasound combined with exercise therapy involving neural mobilisation and joint mobilisation was effective in reducing pain and improving muscle strength in cases of CTS Dextra. This conservative physiotherapy approach has proven to be a safe, effective, and non-invasive option in the management of CTS.

INTRODUCTION

Carpal Tunnel Syndrome (CTS) is a condition caused by compression of the median nerve in the carpal tunnel area and is one of the most common types of neuropathy affecting the upper extremities (Parish et al., 2020; Beddaa et al., 2022). Recent studies indicate that the incidence and prevalence of CTS have increased in recent years, resulting in significant social and economic burdens (Lytras et al., 2020). Individuals with CTS typically experience symptoms such as pain, tingling, sensory disturbances, and weakness in the hands and wrists, which can impair functional ability and disrupt daily activities (Goldberg et al., 2016).

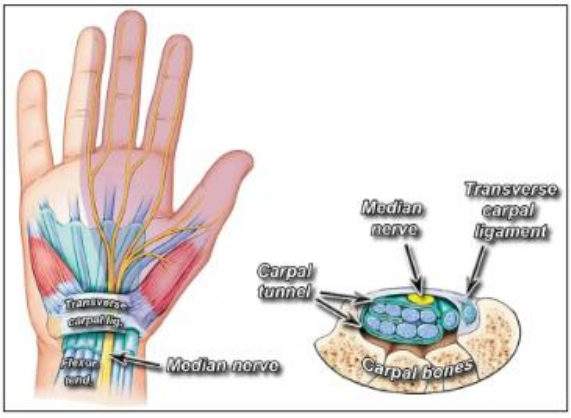

Figure 1. Anatomy of the Carpal Tunnel (Osiak et al., 2022)

According to statistics, Carpal Tunnel Syndrome (CTS) affects 2.7 out of every 1,000 people worldwide. The estimated incidence in the general population ranges from one to five percent, with women having a higher risk of developing the syndrome (0.7 to 9.2%) compared to men (0.4 to 2.1%). Given the high prevalence of CTS, its impact on daily activities, and the costs of healthcare, it is important to identify the best therapeutic approaches (Chalkia et al., 2023). Secondary causes of CTS have been described, including trauma, metabolic conditions, infections, neuropathies, or other systemic disorders (Ijaz et al., 2022).

The clinical signs and symptoms of Carpal Tunnel Syndrome (CTS) typically include irritation in the hand and a tingling sensation in the palm, particularly in the thumb, index finger, middle finger, and radial side of the ring finger. Additionally, patients often experience a decrease in the ability to perform thumb abduction and opposition movements, difficulty in gripping, and overall impaired hand function. CTS symptoms can appear in various areas of the hand, including regions not directly innervated by the median nerve (Genova et al., 2020). These symptoms typically worsen at night, with approximately 77% of patients diagnosed with CTS via electromyography (EMG) reporting numbness or tingling during sleep (Chalkia et al., 2023). This syndrome is more commonly found in women than men, particularly during pregnancy, highlighting the important role of hormones in the mechanism of CTS (Osiak et al., 2022). Contributing risk factors include gender, age, genetic factors, and anthropometric characteristics such as carpal tunnel size. Obesity and diabetes are also known as additional risk factors. Furthermore, CTS may be associated with genetic conditions, rheumatoid arthritis, a history of distal radius fractures, and osteoarthritis of the wrist (Padua et al., 2023).

CTS is associated with work involving repetitive movements and prolonged static positions that can affect nerves and blood supply to the hands and wrists. There are two treatment options: surgical intervention and conservative management. Physiotherapy plays a role in conservative management (Saktiyarini et al., 2023). The aim of this study is to analyse the effectiveness of ultrasound and exercise therapy in pain management and muscle strength optimisation in cases of Carpal Tunnel Syndrome (CTS) Dextra.

METHODS

Case Description

A 42-year-old woman presented with complaints of pain and tingling in her right wrist that radiated to her thumb and index finger, as well as weakness when gripping. The patient first experienced pain during her third pregnancy about 6 years ago. The pain occurred during light or heavy activities involving her right wrist.

Examination

The physiotherapist conducted an examination using the IPPA method (inspection, palpation, percussion, and auscultation). During static inspection,

no signs of cyanosis or bluish discolouration were observed on the patient's hands, and no deformities were noted on either hand. During dynamic inspection, there was a restriction of movement when the patient performed palmar flexion of the right hand. During palpation, tenderness was noted in the right wrist area. Percussion and auscultation examinations were not performed in this session.

Physical therapists also perform specific examinations to confirm a diagnosis of Carpal Tunnel Syndrome, namely Tinel's sign and Phalen's test. The results of both examinations indicate a positive reaction, characterised by the onset of a tingling sensation that radiates to the thumb, index finger, and middle finger of the right hand. The instruments used in the examinations include the Numeric Rating Scale (NRS) to assess pain levels and Manual Muscle Testing (MMT) to evaluate muscle strength.

Method

The interventions provided included ultrasound therapy and exercise therapy in the form of neural mobilisation and joint mobilisation. The Numeric Rating Scale (NRS) was used to assess pain levels, and Manual Muscle Testing (MMT) was used to assess muscle strength. The interventions were administered twice a week for two weeks. NRS and MMT assessments were conducted before and after the interventions.

Intervention

The intervention provided by physiotherapists in cases of Carpal Tunnel Syndrome (CTS) aims to reduce pain and optimise muscle strength. In this study, the intervention consisted of ultrasound and exercise therapy.

Table 1. Intervention

Intervensi	Dosis
Ultrasound	F : 2x/ week I : 3 mHz T : 8 minutes T : Continous
Terapi Latihan	F : 2x/week I : 10 x repetisi 3 set T : 15 minutes T : *neural mobilization and joint mobilization*

RESULT AND DISCUSSION

Result

In this case report study, physiotherapy provided interventions in the form of ultrasound and exercise therapy administered twice a week for two weeks. Based on the evaluation results, there was a reduction in pain and an increase in muscle strength.

1. Pain assessment using the Numeric Rating Scale (NRS)

Table 2. Pain assessment

Type of Pain	T0	T1	T2	T3	T4
Resting pain	5	4	3	2	1
Pressure pain	8	8	7	6	4
Movement pain	8	7	6	5	3

Based on Table 1, it can be seen that the intervention carried out from T0 to T4 had a positive effect on reducing pain intensity. This reduction was significant across all types of pain, indicating the success of the rehabilitation or pain management programme provided. In the static pain category, there was a decrease in pain from an NRS score of 5 to 1. In the pressure pain category, there was a decrease in pain from an NRS score of 8 to 3, while in the pressure pain category, there was a decrease in pain from an NRS score of 8 to 3.

2. Muscle strength evaluation using Manual Muscle Testing (MMT)

Table 3. Muscle strength evaluation

Movement	T0	T1	T2	T3	T4
Extension	4	4	4	4	4
Flexion	4	4	4	4	4
Radial Deviation	4	4	4	4	5
Ulnar Deviation	4	4	4	5	5

Table 2 shows that the intervention carried out from T0 to T4 had a positive effect on increasing muscle strength. In radial deviation and ulnar deviation movements, there was an increase in muscle strength with an MMT value from 4 to 5. Meanwhile, in flexion and extension movements, there was no increase in muscle strength with an MMT value of 4 from before the intervention to the last intervention.

The increase in MMT scores indicates improved muscle strength after intervention. Although not all movements

improved, this may be due to the duration of symptom onset and the possibility of persistent nerve irritation, which requires more time to fully recover.

Discussion

This case demonstrates that physiotherapy interventions in the form of ultrasound and exercise therapy yield positive results in the management of Carpal Tunnel Syndrome (CTS) Dextra, particularly in reducing pain and improving muscle strength. CTS is a common compressive neuropathy caused by compression of the median nerve in the carpal tunnel (Padua et al., 2023). In this case, the patient experienced pain, numbness, and weakness in the right hand, especially when gripping. These symptoms had persisted for a considerable period, dating back to six years ago during pregnancy, further reinforcing the association between hormonal changes and the risk of CTS.

Pain measurement using the Numeric Rating Scale (NRS) showed a gradual decrease in resting pain, pressure pain, and movement pain. This indicates that the intervention provided had significant analgesic effectiveness. This study is in line with the research by Saktiyarini et al. (2023), which showed that ultrasound treatment can reduce pain in CTS patients.

Ultrasonic waves, through the absorption of mechanical energy, generate heat and produce therapeutic effects on tissues. The application of heat can relax muscles, increase local blood flow, reduce inflammation, and promote tissue regeneration. In cases of chronic pain, continuous mode is typically used to target deep tissues, such as tendons or ligaments, and can result in pain reduction (Quarato et al., 2023). Ultrasound application enhances microcirculation, increases cell membrane permeability, promotes protein biosynthesis, regulates muscle tone, and improves cellular metabolism (Guan et al., 2022).

According to Nugroho's research (2024), therapeutic exercises such as neural mobilisation and joint mobilisation reduce pain, improve range of motion (ROM), and enhance functional activity in patients with carpal tunnel syndrome (CTS). Neural mobilisation is a therapeutic technique that can improve symptoms associated with CTS by enhancing the movement of the median nerve. Exercise therapy such as neural mobilisation and joint mobilisation plays a role in reducing pressure on the median nerve, improving soft tissue flexibility, and preventing joint stiffness (Jiménez-Del-Barrio et al., 2022).

Another study by Beddaa et al. (2022) explains the positive effects of neural mobilisation intervention on CTS patients, including reduced pain intensity, increased grip strength, and improved functional status. The underlying mechanism is enhanced axonal transport, leading to improved nerve conduction. Neural mobilisation reduces pressure, thereby increasing blood flow to the nerves, which can also aid in the regeneration and healing of injured nerves (Vaidya, 2020).

The increase in MMT scores indicates improved muscle strength after intervention. Although not all movements improved, this may be due to the duration of symptom onset and the possibility of persistent nerve irritation, which requires more time to fully recover

CONCLUSION

This case study research shows that physiotherapy intervention in the form of ultrasound combined with exercise therapy (neural mobilisation and joint mobilisation) produces significant results in reducing pain and increasing muscle strength in patients with Carpal Tunnel Syndrome (CTS) Dextra. A reduction in pain intensity was observed across all pain categories (resting, pressure, and movement), while muscle strength improvement was achieved in radial and ulnar deviation movements. These findings reinforce the effectiveness of conservative therapy in CTS rehabilitation, particularly in cases with persistent symptoms.

This study makes an important contribution to the development of physiotherapy science, particularly in strengthening clinical evidence regarding the effectiveness of ultrasound modalities and mobilisation exercises in the treatment of compressive neuropathies such as CTS. These findings also support previous literature stating that the combination of thermal and mechanical approaches through this therapy can improve blood flow, reduce inflammation, and improve nerve conduction. With an evidence-based approach, this research adds to the scientific literature that can be used as a reference in non-invasive intervention-based Physiotherapy practice.

In clinical practice, the results of this study can be implemented as part of the conservative management protocol for CTS, especially in patients who choose to avoid surgery. Physiotherapists can adapt the dosage and frequency of interventions according to patient needs, and incorporate a combination of ultrasound and exercise therapy as part of a holistic therapeutic approach. Additionally, this intervention can be widely applied across various healthcare facilities due to its safety, cost-effectiveness, and ease of implementation in outpatient clinic settings.

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