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Transcutaneous Electrical Nerve Stimulation and Neck Calliet Exercise Intervention in Cervical Root Syndrome Cases

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Abstract

Cervical Root Syndrome (CRS) is caused by spinal nerve root compression, manifesting as neck pain, sensory disturbances, and functional impairments. This study evaluates the effectiveness of combining Transcutaneous Electrical Nerve Stimulation (TENS) and Neck Calliet Exercise in managing CRS symptoms. A case study was conducted on a 52-year-old woman presenting with pain and functional limitations due to CRS. The interventions were applied in four sessions over two weeks at Ciremai Hospital, Cirebon. TENS was administered at 50-200 Hz frequency and 50-150 µs pulse duration for 15 minutes, targeting the m. splenius capitis and m. upper trapezius muscles bilaterally. The Neck Calliet Exercise included active movements, isometric contractions, and contract-relax stretching. Pain was assessed using the Visual Analogue Scale (VAS), while functional disability was evaluated with the Neck Disability Index (NDI). Post-intervention results revealed a significant reduction in pain across all neck movements, with some movements achieving complete pain resolution. Functional disability scores improved from moderate (42%) to mild (28%), demonstrating enhanced cervical mobility and motor control. These findings suggest that combining TENS and Neck callit exercise provides a synergistic approach to alleviating pain and improving functional outcomes in CRS patients.

Keywords: Cervical root syndrome, neck calliet exercise, transcutaneous electrical nerve stimulation.

1. Introduction

Cervical root syndrome (CRS) is a condition caused by compression of the spinal nerves or their roots, leading to a complex range of clinical symptoms (Magnus, Viswanath, Viswanathan, & Mesfin, 2024). These symptoms include neck pain, sensory disturbances, muscle dysfunction, and altered reflexes, depending on the affected dermatome distribution (Kang, Lee, & Lee, 2020; Mansfield, Smith, Spahr, & Thacker, 2020). This condition not only impacts the quality of life but also serves as a leading cause of global disability, particularly among individuals in the productive age group. The rising prevalence of this condition underscores the need for more effective and evidence-based therapeutic approaches.

The prevalence of CRS is higher in women compared to men, with a ratio of 1.76:1.07 per 1,000 individuals (Mansfield et al., 2020). Globally, in 2020, neck pain was reported by approximately 203 million people, and this figure is projected to increase to 269 million by 2050, reflecting a 32.5% rise (Wu et al., 2024). These statistics highlight the urgency of addressing neck pain more effectively, especially in the context of CRS. Without proper management, CRS can result in significant functional impairment, economic burden, and decreased quality of life for affected individuals.

Physiotherapy plays a central role in managing CRS by alleviating pain (Vetiani, Wijianto, & Pristianto, 2022), improving joint range of motion, addressing muscle stiffness and weakness, and restoring patients' functional abilities. Common intervention modalities include electrotherapy, such as Transcutaneous Electrical Nerve Stimulation (TENS) (Kushwaha, Verma, Khan, & Sharma, 2022), therapeutic exercises (Liang et al., 2019), and manual therapy (Borrella-Andrés et al., 2021). However, the effectiveness of specific combinations of interventions, such as TENS and Neck Calliet Exercise, in treating CRS requires further scientific investigation.

This study aims to evaluate the effectiveness of the combined intervention of TENS and Neck Calliet Exercise in reducing CRS symptoms, particularly pain and functional limitations. The combination of these two modalities is expected to provide a more holistic approach to managing CRS by leveraging the synergistic effects of electrotherapy and targeted exercise. The findings of this study are anticipated to serve as a reference for evidence-based physiotherapy practice and contribute to the development of more optimal therapeutic protocols for CRS.

Given this context, this study is not only practically relevant to clinical physiotherapy but also academically significant in addressing the literature gap concerning the effectiveness of combining TENS and Neck Calliet Exercise. Furthermore, the outcomes of this research are expected to contribute to reducing the global burden of CRS and improving the quality of life for individuals affected by this condition.

2. Method

This study is a case study aimed at analyzing the effectiveness of Transcutaneous Electrical Nerve Stimulation (TENS) and Neck Calliet Exercise in managing Cervical Root Syndrome. The subject was a 52-year-old woman experiencing pain, stiffness, and a sensation of heaviness in her neck and upper shoulder area. The study was conducted at Ciremai Hospital, Cirebon, in November 2023.

The TENS intervention used a conventional TENS device with parameters of 50-200 Hz frequency, 50-150 μs pulse duration, and intensity up to 50 mA. It was applied for 15 minutes to the bilateral m. splenius capitis and bilateral m. upper trapezius

muscles. The Neck Calliet Exercise began with a warm-up consisting of active movements in flexion, extension, lateral flexion to the right and left, and rotation to the right and left, performed 8 times each. The core exercises included isometric movements held for 6 seconds with 10 repetitions for each direction, combined with contract-relax stretching. The session concluded with active movements following the same pattern as the warm-up. Both interventions were performed in four sessions over two weeks.

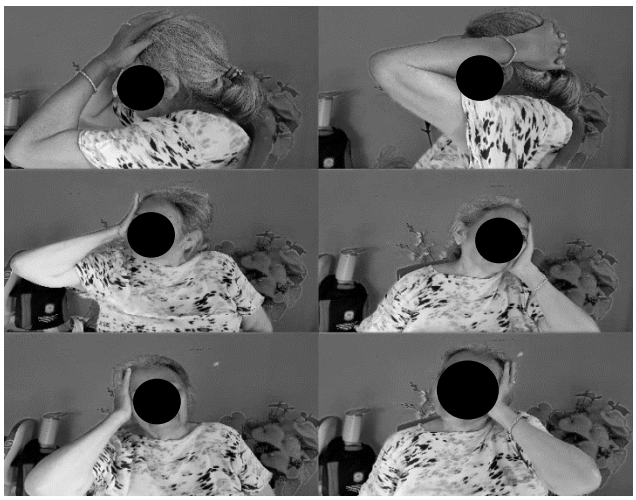

Figure 1. Neck Calliet Exercise

Data collection was conducted through pain level evaluations using the Visual Analogue Scale (VAS) (Saltychev, Mattie, McCormick, & Laimi, 2018) and functional disability assessments using the Neck Disability Index (NDI) (Saltychev et al., 2018; Young, Dunning, Butts, Mourad, & Cleland, 2019). The NDI assesses functional activities through 10 questions covering pain intensity, self-care ability, lifting objects, and other activities. The total score is calculated on a scale of 0-100%, with 0% indicating complete independence and 100% indicating total dependence. This instrument has been validated and proven reliable with an ICC of 0.88 (Young et al., 2019).

Data analysis was performed descriptively to evaluate changes in VAS and NDI scores across therapy sessions. If the subject experienced dizziness or discomfort during the interventions, the session was temporarily paused and resumed when the subject felt comfortable.

3. Results and Discussion

3.1 Pain Scale Changes

Table 1: Pain Evaluation Results using VAS

Movement	Therapy Session			
	TS1	TS2	TS3	TS4
Flexion	3	3	3	2

Extension	5	5	5	4
Right Lateral Flexion	2	2	1	0
Left Lateral Flexion	2	2	2	1
Right Rotation	2	1	1	0
Left Rotation	2	1	1	0

In Table 1, the pain evaluation results show a reduction in pain during the flexion movement, with a pain score of 3 in therapy 1 (TS1) and a decrease to 2 in therapy 4 (TS4). Similarly, for the extension movement, the pain score in TS1 was 5, which decreased to 4 in TS4. For the left lateral flexion movement, the pain score in TS1 was 2, and it decreased to 1 in TS4. Additionally, no pain was found during the right lateral flexion, right rotation, or left rotation movements in therapy 4, indicating a significant improvement in these movements after undergoing therapy.

3.2 Functional Ability Changes

Table 2 Results of Functional Ability Evaluation with the NDI Scale

Item	Therapy Session			
	TS1	TS2	TS3	TS4
Pain Intensity	3	3	3	2
Self-care	2	2	2	2
Lifting	2	2	1	1
Reading	3	3	2	2
Headache	3	3	2	2
Concentration	1	1	1	0
Work	2	2	2	2
Driving	2	2	2	2
Sleeping	2	2	2	1
Recreation	1	1	1	0
Total	21	21	18	14
Total (%)	42%	42%	36%	28%

In Table 2, changes were observed in almost all functional ability items, except for self-care ability, work performance, and complaints while driving. The total percentage in the first therapy session (TS1) was 42%, indicating a moderate level of disability. This showed a significant improvement after the intervention, as the total percentage in the fourth therapy session (TS4) decreased to 28%, reflecting a mild level of disability. These findings demonstrate a notable enhancement in the patient's functional abilities following the therapy sessions.

3.3 Discussion

This case study revealed that the combination of conventional Transcutaneous Electrical Nerve Stimulation (TENS) and Neck Calliet Exercise was effective in reducing movement-related pain. Movement-related pain is a discomfort that can occur either acutely or persistently. This pain is often a maladaptive response to tissue

damage or suboptimal loading, which may result from tissue shortening, prolonged muscle spasms, and stiffness (Corbett et al., 2019; Merkle, Sluka, & Frey-Law, 2020).

The use of TENS in cases of cervical radiculopathy has been shown to reduce pain more effectively than Interferential Therapy (Paolucci et al., 2021; Sharma & Patel, 2014). This is due to the analgesic effect of TENS, which activates large-diameter, low-threshold nociceptive fibers (A-beta) without stimulating small-diameter, high-threshold fibers (A-delta and C fibers) (Johnson, 2021). This mechanism prevents pain signals from entering the central nervous system by utilizing the gate control theory of pain.

In addition to TENS, the Neck Calliet Exercise technique provides a post-isometric relaxation effect that effectively reduces neck pain by quickly relaxing the muscles. This technique combines isometric contractions followed by relaxation and contract-relax stretching, triggering a neurological response that rapidly relieves muscle tension (S., Krishna, & R. B., 2024). When muscles contract against resistance, the Golgi tendon organ is activated, inhibiting contraction and causing a sudden relaxation. This effect is further enhanced when stretching is performed slowly, allowing the stretched muscles to relax. Based on this principle, Neck Calliet Exercise is effective in improving muscle relaxation and reducing spasms.

The combined intervention of TENS and isometric exercises has been proven superior in reducing pain compared to Intermittent Cervical Traction in cases of cervical radiculopathy (Sharma & Patel, 2014). Similarly, this combination is more effective than TENS paired with self-stretching (Dudonienė, Mikalajūnė, Pažėrienė, & Žlibinaitė, 2024). Neck pain has a complex correlation with functional limitations. Reduced cervical muscle performance in individuals with chronic neck pain is significantly negatively associated with functional abilities (Tsang, Szeto, & Lee, 2016). As functional ability decreases, individuals tend to experience increased pain, which may lead to limitations in their social and occupational activities (Martinez-Calderon, Jensen, Morales-Asencio, & Luque-Suarez, 2019).

In this study, the combination of conventional TENS and Neck Calliet Exercise demonstrated an improvement in functional ability, reducing disability from a moderate level to a mild level as measured by the Neck Disability Index (NDI). A greater reduction in disability percentage was observed with passive isometric relaxation combined with TENS compared to self-stretching (Dudonienė et al., 2024). Furthermore, the combination of TENS and isometric neck exercises showed better outcomes in reducing disability and improving functional activity compared to Interferential Therapy. The improvement in functional ability can be attributed to enhanced motor control and increased cervical mobility following pain reduction (Meisingset, Stensdotter, Woodhouse, & Vasseljen, 2016).

4. Conclusion

The combination of Transcutaneous Electrical Nerve Stimulation (TENS) and Neck Calliet Exercise demonstrates significant efficacy in reducing movement-related pain and improving functional abilities in patients with Cervical Root Syndrome (CRS). Pain scale assessments indicate a consistent reduction in pain across multiple neck movements, with some movements showing complete resolution of pain after four therapy sessions. Functional evaluation using the Neck Disability Index (NDI) reveals a decrease in disability from a moderate level (42%) to a mild level (28%) post-intervention, highlighting the synergistic effect of TENS and isometric exercises in enhancing cervical mobility and motor control.

Future studies should consider exploring the long-term effectiveness of this combined intervention in larger and more diverse populations to confirm its generalizability. Additionally, integrating TENS and Neck Calliet Exercise into routine physiotherapy protocols for CRS patients is highly recommended to address pain and functional limitations effectively. Clinicians should tailor interventions based on individual patient needs, emphasizing the importance of combining electrotherapy with targeted exercises for optimal outcomes.

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