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The Impact of Neurodynamic Mobilization and Transcutaneous Electrical Nerve Stimulation on Pain Intensity in Cigarette Company Workers at Risk of Carpal Tunnel Syndrome

Kurnia Putri Utami¹, Tri Ayu Astuti², Zidni Imanurrohmah Lubis³

Department of Physiotherapy, Faculty of Health Science, University of Muhammadiyah Malang

ORCID
Kurnia Putri Utami: <https://orcid.org/0000-0003-3493-2677>

Abstract
Indonesia is one of the largest cigarette producers and consumers in the world. Due to the repetitive activity and long hours experienced by cigarette manufacturer workers who roll the cigarettes, the risk of carpal tunnel syndrome (CTS) is high. They tend to experience pain, numbness and tingling through the hands and fingers. These symptoms occur following compression of the median nerve, which affects their functional ability. Neurodynamic mobilization (NDM) and transcutaneous electrical nerve stimulation (TENS) have been used as physical therapy in management of CTS. However, no studies have yet investigated the effect of the combination of both treatments and compared them. This was a quasi-experimental study with a pre-test post-test design, which compared the effect of a combination of NDM and TENS versus NDM only with cigarette company workers. The workers with the risk of CTS were divided into two groups: the combination NDM with TENS group and the NDM group. The interventions were applied 3 times a week for 1 month in both groups. The visual analogue scale (VAS) was used to measure the pain. The VAS scores were evaluated on the first day before the interventions were given and after 1 month. The Wilcoxon test was used to assess pre and post treatment. The Mann Whitney test was used to compare the effects of both interventions. According to the findings, both groups had a significant change in VAS measurement outcomes. The decrease in pain was larger in the NDM and TENS group than in the NDM group ($p = 0.008$). Carrying out a combination of NDM with TENS 3 times in a week for 1 month had a substantial impact on decreasing pain in cigarette workers with CTS risk

Keywords: neurodynamic mobilization, TENS, carpal tunnel syndrome, pain, cigarette workers

1. INTRODUCTION

Cigarette workers spend time working and doing repetitive movements on their hands over and over again for long periods such as flexion movements and extensions on the fingers. This allows these workers to be exposed to RSI (Repetitive Strain Injury) which is the term for cases of injuries that occur in muscles, tendons and nerves caused due

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Indonesia is one of the largest cigarette producers and consumers in the world. Due to the repetitive activity and long hours experienced by cigarette manufacturer workers who roll the cigarettes, the risk of carpal tunnel syndrome (CTS) is high. They tend to experience pain, numbness and tingling through the hands and fingers. These symptoms occur following compression of the median nerve, which affects their functional ability. Neurodynamic mobilization (NDM) and transcutaneous electrical nerve stimulation (TENS) have been used as physical therapy in management of CTS. However, no studies have yet investigated the effect of the combination of both treatments and compared them. This was a quasi-experimental study with a pre-test post-test design, which compared the effect of a combination of NDM and TENS versus NDM only with cigarette company workers. The workers with the risk of CTS were divided into two groups: the combination NDM with TENS group and the NDM group. The interventions were applied 3 times a week for 1 month in both groups. The visual analogue scale (VAS) was used to measure the pain. The VAS scores were evaluated on the first day before the interventions were given and after 1 month. The Wilcoxon test was used to assess pre and post treatment. The Mann Whitney test was used to compare the effects of both interventions. According to the findings, both groups had a significant change in VAS measurement outcomes. The decrease in pain was larger in the NDM and TENS group than in the NDM group ($p = 0.008$). Carrying out a combination of NDM with TENS 3 times in a week for 1 month had a substantial impact on decreasing pain in cigarette workers with CTS risk

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1. INTRODUCTION

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Corresponding Author: Kurnia Putri Utami; email: kurniaputri01@umm.ac.id

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to Repetitive movements activity. One of the diseases classified as RSI that can affect cigarette workers is CTS (Carpal Tunnel Syndrome) [1, 2].

CTS (Carpal Tunnel Syndrome) is a neuromuscular disease caused by compression or pressure in the median nerve in the carpal tunnel of the wrist that can cause numbness, tingling, paresthesia and nocturnal pain [3]. The prevalence of CTS in the general population is estimated at 1-5%, while in the working population by 5-21% [4]. According to previous research, the prevalence of CTS in work with a high risk of wrist and hand use is 5.6-15% [4].

Physiotherapy intervention in the form of giving Neurodynamic Mobilization and TENS becomes a choice for treat CTS cases. NDM is an effective manual therapeutic intervention given to people with CTS to reduce pain, improve nerve conduction and improve functional status in people with CTS [5]. Tens is a physiotherapy modality that is also effective for reducing pain in people with CTS through the release of endogenous opiates into circulation and inhibition of pain transmission through Gate Control Theory [6, 7].

Manual therapy technique NDM (Neurodynamic Mobilization) serves to restore the plasticity of the nervous system and the ability of nerve tissues to stretch and stiffen. In addition, it can also reduce pain, increase mobility of the median nerve, increase blood supply, reduce the mechanosensitivity of the nervous system and improve functional [5, 8]. NDM is reported effective to treat symptoms of CTS [9]. The technique used in this exercise is the stretch of neural tissue so that the compression of nerve can be minimized and blood flow to neural tissues increase. When the nerve regenerates its tissues, the existing problems will be decreased.

TENS (Transcutaneous Electrical Nerve Stimulation) is a physiotherapy modality by the application of electrical current that has electrodes which is placed on the surface of the skin to stimulate peripheral nerves [10]. This tool serves to disrupt and block pain pathways through the gate control theory method with a frequency of 80-100 Hz, pulse width 350 μ sec, and amplitude according to patient sensitivity approximately 0-80mA [11]. TENS excite sensory so that the impulses of A β fibers increase, then enter the dorsal horn on the spinal cord to stimulate gelatinous substance. It triggers the inhibition of A δ and c transmission and lead to decrease the pain [10].

Previous studies have shown positive effects of neurodynamic mobilization interventions and TENS in lowering pain in CTS. In this study, both interventions combined with the goal of increasing the effectiveness of the intervention and the pain-reducing effects may last much longer than giving one intervention only.

2. METHODS

2.1. Study Design

Quasi-experimental with pre-test and post-test design by taking causal relationship between the dependent variable and the independent variable. This design was used to compare the effect of combination NDM and TENS with NDM only to Cigarette Company Workers.

2.2. Subjects

The samples in this study were cigarette workers with a total of 24 respondents. Sampling technique using purposive sampling with inclusion criteria is a cigarette employee that works more than 4 hours a day, experiencing Carpal Tunnel Syndrome with positive results in specific examinations in the form of Tinel Test and Phalen Test, able to follow all research procedures, willing to be the subject of research and have signed informed consent. The exclusion criteria in this study are respondents who are undergoing pharmacological therapy to reduce pain, there are contraindications of Neurodynamic Mobilization and TENS interventions such as the presence of epilepsy, the use of pacemakers, cauda equina lesions, acute infections and injuries to the spinal cord, there are open wounds and there are sensory problems on the skin. The sample is divided into two groups. NDM-TENS group was given a combination of NDM and TENS while NDM group was given NDM intervention only.

2.3. Neurodynamic Mobilization (NDM)

There are two NDM technique that is used in this study, tension techniques and sliding techniques. In the tension technique the hands and neck are moved slowly in opposite directions, where the position of the hand starts from shoulder abrasion, elbow extension, elbow supination, dorsiflex wrist and neck are moved in the lateral direction of flexion in the opposite direction. As for the sliding technique, the movement is the opposite of the tension technique, where the position of the hand starts from shoulder abrasion, flexi elbow, elbow supination, palmar flexi wrist and neck is moved towards the lateral flexi towards the hand. This movement is done ipsilaterally. This exercise is done 3 times / week for 4 weeks with 10 repetitions of each movement with 15 seconds rest and done as many as 3 sets.

2.4. Transcutaneous Electrical Nerve Stimulation (TENS)

This study used TENS KWD 808i (Electric TENS). TENS modality application uses two electrodes with coplanar technique where the first electrode is attached to the transverse ligament and another electrode is affixed as far as 10 cm from the first electrode, precisely in the flexor digitorum. superficialis. This modality is given 3 times in 1 week for 4 weeks. The duration of intervention is 20 minutes with a frequency of 80-100 Hz and intensity according to the sample's tolerance.

2.5. Pain Measurement

Visual Analogue Scale (VAS) was used to measure the pain. VAS was evaluated in the first day before the interventions was given and after 1 month.

2.6. Statistical Analysis

Wilcoxon test was used to assessed pre and post due to the failure of the number of rearing data in normality test. Mann Whitney Test was used to examine the comparison of both interventions effect. All statistical analyses were performed using IBM SPSS for windows version 20.0

3. RESULT

TABLE 1: The effect of combination Neurodynamic Mobilization with TENS and Neurodynamic Mobilization only to decreasing pain in Cigarette Workers with CTS risk

Groups		n	mean	p	α	df
NDM-TENS	Pre-test	12	6,250	0,002	0,05	12
	Post test		1,275			
NDM	Pre-test	12	4,542	0,002	0,05	12
	Post test		2,292			

Wilcoxon Test: NDM-TENS = Combination of NDM and TENS; NDM = NDM only; n = number of samples; mean = mean of VAS measurement result; p = p-value; α = significance level; df = degree of freedom

Data of the effect of interventions in NDM-TENS group and NDM group are presented in table 1. The Wilcoxon test revealed that interventions in both groups has significant effect to decreasing pain. After treatment of combination of Neurodynamic Mobilization with TENS, the score of VAS was significantly lower with p-value 0,002. The significantly

change was also found in Neurodynamic Mobilization group. The data showed that the pain score used VAS went down with p-value 0,002.

TABLE 2: The Comparison of combination Neurodynamic Mobilization with TENS and Neurodynamic Mobilization only to decreasing pain in Cigarette Workers with CTS risk.

	p	α
NDM-TENS vs NDM	0,008	0,05

Mann Whitney Test: NDM-TENS = Combination of NDM and TENS; NDM = NDM only; p = p-value; α = significance level

Table 2 shows the data of comparison of combination Neurodynamic Mobilization with TENS and Neurodynamic Mobilization only to decreasing pain. Mann Whitney test demonstrated a significant different effect between two interventions with p-value 0,008. This analysis revealed that the combination of Neurodynamic Mobilization with TENS gives more positive result to decrease the pain than Neurodynamic Mobilization only in CTS.

4. DISCUSSION

TENS can reduce pain by stimulating $A\beta$ and sending impulses up into the dorsal horn on the spinal cord and activating the interneuron cells in gelatinous substances that can cause increased control of pre synapse, closing gates and transmission. The afferent pathway produced by the nerve fibers $A\delta$ and C are blocked. This causes the pain messages carried by nerve fibers $A\delta$ and C are not transmitted and do not reach the sensory center so that the pain felt by the patient becomes reduced [12]. Beside this gate control theory, other mechanism such as restoration of afferent input and stimulation of endogenous opiates secretion in the brain and sympathetic blockage could explain the pain management of TENS [13, 14].

Administration of NDM after TENS intervention in the case of CTS can improve the axonal transport of nerves, increase blood flow to nerve tissue, release nerve irritation caused by the clamping of median nerve in the carpal tunnel that will increase nerve elasticity due to the effects of stretch on the nerve [15]. This technique decrease the edema and adhesion in CTS as a biomechanical effect. Furthermore, movement of the joints in the hands will facilitate blood circulation and neuromodulator effects from NDM such as the decrease of nociception of median nerve lead to pain modulation [16]. Previous study showed that the administration of NDM has significant therapeutic benefit in carpal tunnel syndrome [17, 18]. The use of NDM improve physiological function which is reduce interneural oedema and decrease interneural pressure. It produced a

significant reduction in pain, improvement of nerve conduction in sensory fibers and increase functional status [17, 19].

Neurodynamic Mobilization (NDM) has two techniques that focus on reducing entrapment on the nerves. These techniques are sliding and tension. These two techniques have different focuses. Technique of sliding focused on reducing Inflammatory and oedema because when making movements sliding will help drainage at vascular so that substance p (inflammatory mediator) and the protein will decrease and oedema reduced. Reduced oedema it will increase transport of axonal and reduce the effect mechanosensitivity on the nerves [20]. In the other hand, the technique of tension focused on reducing pain, regeneration nerves and increases the flexibility of nerve. Stretch movement in this technique will reduce pain due to pressure in median nerve of carpal tunnel, facilitate the flow of blood that will deliver oxygen, nutrition, and components tissues regeneration (mRNA, Lipid, and Protein) that will stimulate Schwan cells which has a function to repair myelin and provide nutrition. When Schwan cell stimulated, the cell will undergo an extension. If the cell is getting longer, then the nutrients in the cell are also accumulate causes nerves regeneration become faster. Moreover, the movement tension will also improve flexibility of nerves that focus on breaking the chain of connective tissue formation in the nerves (fibrosis) so that there is no pressure on the nerves that will trigger the occurrence of repeated oedema [5].

A significant reduction in pain from the combination group of TENS and NDM interventions may occur because the resulting effects of the combination of the two interventions suggest that if TENS intervention is used as a modality, it can reduce symptomatic pain of CTS in a short period of time by closing the pain gate [21]. After that, giving intervention of NDM can diminish causative due to pressure of median nerve in the carpal tunnel and also mitigate symptomatic pain in a long period of time. Thus, if the two interventions are combined can maximize the purpose of the intervention to reduce pain in a short period of time [21]. While in the group that was only given of NDM intervention there was also a decrease in pain. However significant decrease was more seen in the combination group. This is because, this group only obtained physiological effects and therapeutic effects from NDM intervention alone. This intervention has more visible effect if it is done over a long period of time, while in a short period of time the effect is not too significant to lessen a pain [22].

5. CONCLUSION

The combination of Neurodynamic Mobilization and TENS has a greater effect on decreasing a pain compared to Neurodynamic Mobilization only in Cigarette workers with CTS risk.

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