ORIGINAL ARTICLE

Physical Therapy Journal of Indonesia (*PTJI*) 2023, Volume 4, Number 1: 31-35
E-ISSN : 2722-6034 ; P-ISSN : 2722-0125

The effect of neural mobilization against sensorineural symptom reduction among hand-arm vibration syndrome survivor

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ABSTRACT

Background: Hand-arm vibration syndrome (HAVS) is an occupational disease caused by exposure to vibration from work tools. Complaints often arise from sensorineural disorders that cause the arms and hands to tingle, numb, and experience decreased sensitivity. Neurodynamic mobilization is a manual therapy technique that utilizes tension and sliding movements that can reduce symptoms of sensorineural disorders. This study aims to determine the effect of neurodynamic mobilization on reducing sensorineural symptoms in patients with HAVS in welding workshop workers in Malang city.

Methods: The design of this study used a pre-experimental approach with a one-group pretest-posttest design approach. There were 15 samples of welding workshop workers with symptoms of sensorineural disorders. The sample was given intervention for one month at a dose of 3x/week with one exercise consisting of 20x/set (10 slidings and ten tension) with three repetitions and a rest interval of 15 seconds/set. The assessment and evaluation instrument uses the Stockholm workshop scale. Data analysis was using the Wilcoxon test.

Result: A significant decrease ($p<0.000$) in sensorineural symptoms among welding workshop workers in Malang city after a neurodynamic mobilization intervention was given.

Conclusion: It can be concluded that providing neurodynamic mobilization decreases sensorineural symptoms of HAVS sufferers in welding workshop workers in Malang city.

Keywords: Hand Arm Vibration Syndrome, Neurodynamic Mobilization, Sensorineural, Welding Workshop.

Cite this Article: Marufa, S.A., Widodo, T.N.C., Rahmanto, S., Utami, K.P. 2023. The effect of neural mobilization against sensorineural symptom reduction among hand-arm vibration syndrome survivor. *Physical Therapy Journal of Indonesia* 4(1): 31-35. DOI: 10.51559/ptji.v4i1.66

BACKGROUND

Frequent exposure to vibration during working can transmit shaking effects to the arms and hands. That condition may cause vascular, neurological, and musculoskeletal disorders along the arms, termed hand-arm vibration syndrome (HAVS).[1] HAVS is an occupational disease because electric tools produce high-frequency vibrations.[2] The initial symptom is tingling or numbness in parts of the body, especially the arms, hands, and fingers.[3]

Besides the duration of vibration tools, the high vibration speeds can cause permanent damage, affecting work productivity and disturbing comfort.[4] Inflammatory mediators, such as cytokines, prostaglandins, and neuropeptides, will increase dorsal root ganglion during inflammation. Besides, to increase neural excitability and behavioural sensitivity for inflammation, the type of prostaglandins E2 or PGE2 has been identified as a critical mediator. The G-protein receptor shows that EP2 is involved in the pathophysiology of painful joint conditions.[5]

Globally, the prevalence of workers experiencing HAVS is around 5% to 80%, depending on the type of tool used, frequency of vibration exposure, and climate factors.[6] In a previous study conducted on 200 tire shop mechanics in Malaysia, 29.5% of workers experienced numbness in their fingers, and 20% reported complaints of tingling in their fingers. Based on a study conducted in countries with industrial worker demographics such as mining, construction, and metal workers, it is estimated that 50% of workers experience HAVS disorders.[7] In Canada, 72,000-140,000 workers experience HAVS disorders.[2] In Indonesia, it is still unknown the prevalence of sufferers experiencing HAVS.[3]

Recently, we found limited literature discussing curing methods for HAVS sufferers. However, HAVS is closely related to carpal tunnel syndrome (CTS) because most HAVS sufferers have a high risk of CTS.[8] Neurodynamic mobilization (NDM) is a technique that uses sliding and tension movements by utilizing the mechanical and physiological effects of the nervous system connected to the musculoskeletal system.[9] The automatic function consists of tension, sliding, and compression, as well as physiological functions consisting of intraneural blood circulation, impulse velocity,

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Received : 2023-02-01
Accepted : 2023-03-25
Published : 2023-04-11

axonal transport, inflammation, and mechanical sensitivity.[10]

NDM is one of the treatment options that can be used for symptoms such as pain, nervous system disorders, loss of touch sensation, and decreased movement function. Mobilization exercises effectively reduce the symptoms due to the advantage of training for increasing venous circulation of the nerves, reducing nerve pressure, increasing blood flow to the median nerve, and mobilizing the median nerve.[11]

Providing NDM can effectively improve nerve conduction, improves functional levels, and reduces pain and the severity of symptoms in patients with carpal tunnel syndrome in the short term.[12] It can increase sensory conduction and median motor nerve in patients with mild and moderate categories of CTS. NDM can reduce nerve pressure, increase blood flow, and increase axonal transport and nerve conduction.[13]

Significant intervention results can be influenced by the concepts of nerve tension (stress and strain) and glide (excursion), as well as the reduction of mechanical forces on nerves and stretching of fibrotic tissue, which can reduce inflammatory infiltration and reduce pro-inflammatory inflammation around nerves and neurons which can stimulate neo vascularised tissue causes an increase in the supply of oxygen and nutrients to the nerves. To the best of our knowledge, due to the limited study number of HAVS in Indonesia. Besides the difficulty in finding the incident number and effective treatment.[4] This study aims to analyze the effect of NDM against sensorineural symptom reduction among HAVS survivors.

METHODS

Characteristic of participants

In this present study, a total of 15 participants who meet our criteria were recruited. We use non-probability sampling to determine suitable participants with the requirements as follows; welding workers with a working duration of approximately 8 hours; experienced in using vibration tools along hand-arm; classified under sensorineural disorder based on Stockholm workshop scale (SWS) measurement; the pain results measurement by visual analog scale (VAS) above 5mm; and willing to participate in this study.

We excluded the participant who has diabetic history and acute wrist fracture and is not recommended to receive NDM treatments due to acute inflammation, nerve infection, and irritable condition. All participants explained the study process and received an informed consent sheet once they agreed to participate.

Study assessments

After finding the welding population, we investigated whether they have sensorineural disorders along hand-arm. To assess the sensorineural function, we used the SWS, which can classify severity changes of sensory function. In detail, this scale was utilized in the previous study to determine the severity of vascular and sensorineural disorders.[14] The initial specific test before SWS evaluation includes a cold sensation test, palpation test, pain sensitivity test, and temperature test.[15]

The result of the SWS test was classified into four categories sensorineural (SN); 0 SN (exposed to vibration, no symptom); 1 SN (intermittent numbness, with or without tingling); 2 SN (intermittent or persistent numbness, decreased sensory perception); 3 SN (intermittent or continuous numbness, decreased tactile discrimination).[16] After evaluating the participant's sensorineural level, neurodynamic mobilization was delivered within a month (3 times/week, consisting of 20 repetitions: 10 sliding movement and ten tension movements with 15 seconds rest interval, in total, there is three sets). Post-neurodynamic mobilization treatment, all participants were evaluated with SWS to check for any changes in their sensorineural level.

Statistical analysis

We used SPSS (software version: 24.0; doc number: 724325, New York, US) to analyze all statistical data in this present study. Wilcoxon test was used to analyze the effect of NDM against sensorineural reduction among HAVS survivors in our research. Assumption of data processing with values through a significant level of the p-value ($\alpha = 0.05$).

RESULTS

A total of 15 male welding workers in Malang city were recruited in this study. The demographic result in table 1 shows the age category among our participants were classified into three: (1) 6 young adults (26-35 years old); (2) 6 middle-aged adults (36-45 years old); (3) 3 old adults (46-55 years old). Those classifications are based on age groups in Indonesia and have been regulated by the Indonesian Ministry of Health. Besides age, we collected their work experience data; there were six workers with less than five years of experience (40%) and nine workers with more than five years (60%). We classified the divided groups in work experience based on a previous study when ≤ 5 years were categorized as beginner workers while ≥ 5 years were organized as more experienced workers. However, all participants in this study

Table 1. Demographic Data.

Demographic Characteristic		%
Age	Years	
	Young adults	40
	Middle-aged adults	40
	Old adults	20
Work experience	Years	
	≤ 5	40
	≥ 5	60
Work duration	Hour	
	8	100
SWS stadium Pre-NDM	Score	
	1 SN	26.7
	2 SN	46.7
	3SN	26.7
SWS stadium Post-NDM	Score	
	0 SN	40
	1 SN	33.3
	2 SN	26.7

NDM, neurodynamic mobilization; SN, sensorineural

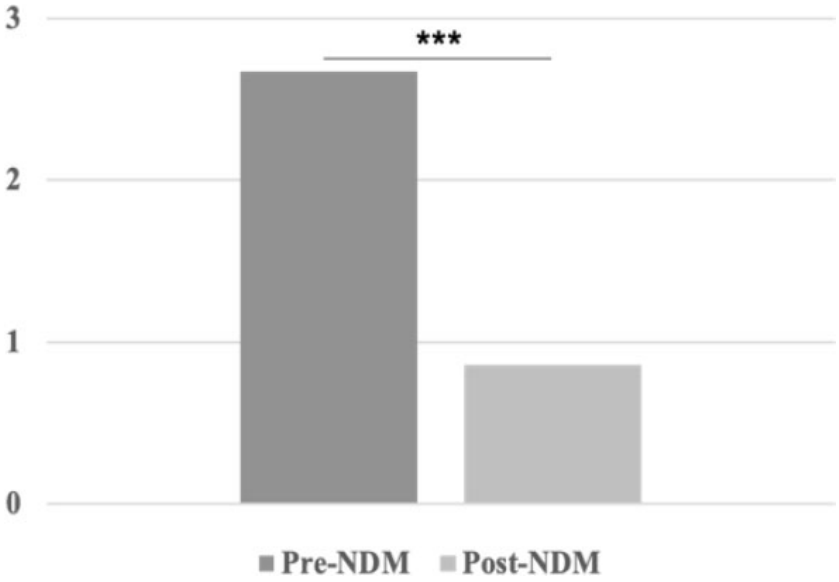

Figure 1. Stockholm workshop scale (SWS) Score among welding workers pre- and post-neurodynamic mobilization (NDM). ***, significantly different between pre- score and post-intervention score $p< 0000$.

have the same work duration (8 hours per day).

SWS in our study aims to measure sensorineural disorder among participants. Before and after the NDM exercise, we calculate the score and compare it. From the pre-NDM result, 4 participants were identified as having intermittent numbness, with or without tingling (26.7%), 7 participants were identified as having intermittent or persistent numbness and decreased sensory perception (46.7%), 4 participants were identified as having intermittent or continuous numbness, decreased tactile discrimination (26.7%). Further, the SWS score at post-NDM showed 6 participants identified recovery (no symptom), 5 participants were in stadium 1, and 4 participants were in stadium 2.

Based on the Wilcoxon test, a significant reduction of sensorineural symptom among HAVS survivor working as welding workers were found (p<0.000). Figure 1 shows a substantial difference between SWS scores pre and post-NDM exercise.

DISCUSSION

In this study, most workers affected by sensorineural disturbances with HAVS were aged 26-35 years old by 40% and 36-45 years old by 40%, and 46-55 years old by 20%. Based on a previous study, workers aged over 36 years are more susceptible to HAVS complaints because older workers have less awareness to work safety. In addition, as people get older, it causes a decrease in physiological body function, such as decreased joint flexibility.[17] Decreased joint fluid production can cause inflammation and pain that provokes HAVS symptoms. The increasing age of a person in a productive period can cause a change in their function to become weak and experience degenerative processes gradually. Weakening of the organs causes less elasticity in blood vessels. This condition makes the body increasingly vulnerable to exposure to machine vibrations produced by grinding.[18]

Based on the respondent's work experience characteristics, the welding workshop workers primarily work in the extended service category (> 5 years). Based on previous research, there were seven dental technician workers at the University of North Sumatra experiencing HAVS complaints with a working period of more than five years.[19] A person's length of work can affect the appearance of complaints of HAVS because the longer a person's working period, the more often the person is exposed to vibrations produced by work tools that generate vibrations, causing a significant potential for HAVS, which affects stiffness and decreases the elasticity of the vascular blood channels.[18] In addition, the long working period can affect physical complaints due to work because workers make many repetitive movements while working for very long working periods.[4]

Based on the characteristics of work duration, there are 15 workers whose average duration of work is <8 hours per day. Exposure to vibration with vibrating machines and tools for a long time on the hands can cause peripheral microcirculation, which causes sensorineural disturbances in the arms and hands.[15] Exposure to vibration for a long time and high vibration intensity can cause damage to the musculoskeletal system.[4] HAVS complaints

can appear a month or even a year after someone is exposed to vibrations. Symptoms can get worse if exposed continuously, and symptoms can become permanent and even cause disability in the hands, which can affect work productivity.[17]

Based on research conducted by administering NDM interventions to reduce sensorineural symptoms of HAVS sufferers in welding workshop workers in Malang City, there is a significant value between before and after NDM administration. After a month of intervention with a dose of 3x/week carried out 20 repetitions (10 sliding movements), (10 tension movements) with repetition of 3 sets with 15-second rest intervals, there was a decrease in sensorineural symptoms in HAVS patients during evaluation. Since the effects of HAVS are progressive, the symptoms get worse with continuous exposure to vibration.[20] Most workers experience sensorineural symptoms with complaints like tingling and numb fingers. Examining HAVS symptoms can be done by a physical examination which can be classified using SWS, which contains the stage and degree of severity based on the symptoms that appear based on the physical examination results.[15]

NDM is one of the treatment options that can be used for symptoms such as pain, nervous system disorders, loss of touch sensation, and decreased movement function. Mobilization exercises effectively reduce the symptoms that arise because these exercises have the benefit of increasing venous circulation of the nerves, reducing nerve pressure, increasing blood flow to the median nerve, and mobilizing the median nerve.[11]

NDM utilizes two movement techniques, namely sliding and tension. The sliding method helps to channel the blood supply so that inflammatory connectors (substance p), protein, and intraneural edema will be reduced. When intraneural edema is reduced, axonal transport will be smooth. Respectively, mechano-sensitivity will be decreased in the nerves while the sensitivity of the fingers begins to improve. This sliding movement functions more to reduce inflammation and intraneural edema, and it provides sensorineural and functional improvements.[21]

Tension movements can have a stretching effect and stimulate Schwann cells. The role of Schwann cells is to help distribute nutrients and regenerate myelin. When Schwann cells get stimulation, there will be an extension of the cells aimed at increasing the production of nutrients because the longer the Schwann cells, the more nutrient content is produced. The amount of nutrient content can help the nerve cell regeneration process faster. Tension movements can also increase nerve flexibility, stopping the formation of connective tissue fibrosis chains so that edema will not recur. The exercise focuses on regenerating nerves and increasing nerve flexibility.[22]

Administration of NDM interventions can increase axonal transport and nerve conduction, reduce nerve pressure so nerves can move freely, reduce adhesions, and increase blood flow that carries oxygen and nutrients to help regenerate damaged nerves.[23] NDM can occur due to reduced pressure in the nerves, resulting in increased blood flow to the nerves. This mechanism increases axonal transport and nerve conduction. In addition, there is a decrease in the mechanical strength of the nerves and stretches the fibrotic tissue, which functions to reduce inflammatory infiltrates and pro-inflammatory release around nerves and neurons, thereby stimulating tissue neovascularization, which can increase the supply of oxygen and nutrients to nerves.[13]

NDM movements that are carried out actively and passively can help reduce pressure on the nerves, intra- and extra-median nerve edema, as well as increase axoplasmic circulation and release of nerve adhesives to provide increased sensory and motor conduction in the nervous system, which can make the sensory and motor systems progressively getting better.[24] The effect of giving neurodynamic mobilization can increase axonal transport, increase nerve conduction and reduce pressure in the nerves, resulting in increased blood flow in the nerves. This increased blood flow will bring a lot of oxygen and nutrients to help heal, and symptoms such as paresthesia and numbness can be reduced.[25]

However, we should acknowledge our study limitation; First, the limited number of HAVS survivors among welding workers and the detailed identification of other workers exposed to vibration tools should be analyzed soon. Second, the research was carried out for approximately one month due to limited research time and the inability to evaluate the therapy's long-term effects.

CONCLUSION

In this present study, we focused on welding workers, who are exposed daily to work vibration devices for hours. NDM is one of the exercise techniques come to reduce inflammation and improve sensitivity, as well as sensorineural function. Our finding showed a significant sensorineural reduction after NDM exercise within a month.

CONFLICT OF INTEREST

There is no conflict of interest that the author declares following the publication.

ETHICAL CONSIDERATION

The authors obtained informed consent that the sample had been approved before conducting the study.

FUNDING

This current study was generously funded by a research block grant from the Faculty of Health Science, University of Muhammadiyah Malang (E.5.a/1194/FIKES-UMM/X/2022).

AUTHOR CONTRIBUTIONS

SAM conceived the study design, collected and analyzed the data, and drafted the manuscript; TNCW, SR, and KPU interpreted the data analysis and drafted the manuscript.

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