JPJO 8 (2) (2023) 217-227

Jurnal Pendidikan Jasmani dan Olahraga

Available online at:
https://ejournal.upi.edu/index.php/penjas/article/view/58228
DOI: https://doi.org/10.17509/jpjo.v8i2.58228

Neurodynamic Sciatic Nerve Slider and Passive Stretching Techniques to Reduce Pain and to Increase Hamstring Muscle Flexibility

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Article Info

Article History :
Received Mei 2023
Revised August 2023
Accepted August 2023
Available online September 2023

Keywords :
Flexibility, Neurodynamic Sciatic Nerve Sliders Technique, Passive Stretching

Abstract

Short hamstring syndrome is a condition caused by a reduction of the length of hamstring muscles causing muscle tension, muscle strain, and limitations in movements and functions. The purpose of this study was to determine the efficacy of the neurodynamic sciatic nerve slider technique and passive stretching technique on reducing pain and increasing flexibility of the hamstring muscles of tailors with short hamstring syndrome. This study was an experimental study with pre-test and post-test two group design. The sample of the study consisted of 22 people given the neurodynamic sciatic nerve slider intervention, for Group 1, and passive stretching intervention, for Group 2. Pain was measured using a visual analogue scale (VAS), while hamstring muscle flexibility was tested by active knee extension (AKE) measured before and after interventions. Data analysis used paired sample t-test and independent sample t-test. The paired sample t-test result for pain data of Group 1 was p = 0.000 (p <0.05), while the result of Group 2 was p = 0.000 (p <0.05). For the data of the hamstring muscle flexibility, Group 1 obtained p = 0.000 (p <0.05) and Group 2 obtained p = 0.000 (p <0.05). Independent samples t-test for pain obtained an average score after treatment of 1.48 ± 1.10 for Group 1 and 2.37 ± 0.76 for Group 2 with a value of p = 0.039 (p <0.05). For flexibility data, the mean after treatment was 165.00 ± 4.05 for Group 1 and 155.00 ± 8.33 for Group 2 with a value of p = 0.002 (p <0.05). These results conclude that neurodynamic sciatic nerve slider technique and passive stretching technique can reduce pain and increase hamstring muscle flexibility in tailors with short hamstring syndrome.

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INTRODUCTION

Static sitting activities for a long time in tailors might lead to physiological changes in the muscles, such as a decrease in neural input in the muscle fibers causing changes in muscle mass and muscle metabolism which will have an impact on the decreased elasticity of the hamstring muscles (Page et al., 2010). Working for hours in front of a sewing machine and the sitting position will affect muscle elasticity. Changes in the hamstring muscles will result in excessive muscle work. Excessive muscle work for a long time on the motor unit will result in accumulation of metabolic waste, causing disruption of Calcium Ion Homeostasis in muscle cells (Kisner & Colby, 2017). Disruption of Calcium Ion Homeostasis in muscle cells will cause autogenic damage to the muscle cell membrane which in turn causes damage to the myofilaments structure in the muscles. The damage in the myofilament structure will cause muscle pains due to the sensation of tension which results in limited movements and impaired functional activities (Dommerholt & Huijbregts, 2011). Sitting in an unergonomic position, such as bending, causes a reduced lordosis curve from the lumbar, the pelvis will tilt posteriorly resulting in shortening of the hamstring muscles (Irawati et al., 2020).

The hamstring muscle is a large muscle in our body. This muscle consists of three muscles, namely the biceps femoris, semitendinosus, and semimembranosus. The hamstring muscles are located on the back side of the thigh used for knee flexion, hip extension, and external and internal rotations of the hip. This muscle originates at the ischial tuberosity, inserts on the tibia bone, and is innervated by the sciatic nerve (Kisner & Colby, 2017). The hamstring muscles help in movement during daily activities, such as walking and running, and in maintaining body posture and balance. The hamstring muscle problem is often experienced by both people who often do sport activities and people who rarely do sport activities, which can reduce the level of muscle flexibility (Shinde & Kanase, 2017). The decrease in the hamstring muscle flexibility will cause shortening of the hamstring muscles, known as short hamstring syndrome.

Short hamstring syndrome is a condition caused by a reduction in the length of the hamstring muscle tissue and causes muscle tension, muscle strain, and limitations of movements and functions. One of the factors causing short hamstring syndrome is poor flexibility, nervous tension, muscle imbalance, and a history of previous injuries (Vakhariya et al., 2016). Of all these factors, the main cause of hamstring injuries is poor flexibility. Flexibility is the ability of a tissue or muscle to reach maximum joint movement without pain. Decreased physical activity is one of the causes of decreased hamstring muscle flexibility. The flexibility of the hamstring muscles is necessary because this muscle contributes to daily mobility (Ganesh, 2017).

A continuous static activity and lack of physical activity carried out for a long time are the reasons of the shortening of hamstring muscles. Static activities with stagnant body positions can reduce the elasticity level of muscle tissue so that muscles will experience impaired flexibility and pains (Shinde & Kanase, 2017). Decreased flexibility in the hamstring muscles often becomes the cause of muscle injury. However, nervous tension and immobility are also the main factors causing pain and shortened hamstring muscles. Nerve immobility can lead to reduced muscle length. The inability to achieve more than 20 degrees of knee extension in 90 degrees of hip flexion accompanied by discomfort is a sign of the hamstring muscle shortening (Babu et al., 2015). Changes in length of the hamstring muscles can cause pain and decreased flexibility that can interfere with daily activities.

Flexibility is needed to support daily activities, therefore it is important to have a good muscle flexibility. The measurement of hamstring muscle pain can use the Visual Analogue Scale, while the measurement of the hamstring muscle flexibility can use Active Knee Extension (Davis et al., 2008). One of the interventions that can be used to increase the hamstring muscle flexibility in people with short hamstring syndrome is the neurodynamic sciatic nerve slider technique and passive stretching technique.Neurodynamic sciatic nerve slider technique is a nerve mobilization technique that integrates musculoskeletal structures and the nervous system to reduce pain and increase joint range of motion. The neurodynamic sciatic nerve slider technique can increase the range of motion of the joint due to a decrease in mechanosensitivity of the nerves so that it can increase the range of motion of the joint. This intervention causes active stretching where the nervous system is made tight and then relaxed to reduce the effects of nerve mechanosensitivity by providing movements that lead to neurodynamic changes and sensation modifications that can reduce pain and increase hamstring muscle flexibility (Shinde & Kanase, 2017).

The next intervention that can be used to reduce pain and increase the flexibility of the hamstring muscles is passive stretching. Passive stretching is a stretching method that is commonly used to increase the flexibility of postural muscles. This stretching method can actively increase flexibility by producing stretching of the sarcomere to restore the disturbed elasticity of the sarcomere. Stretching the antagonist muscles slowly causes the muscle spindles to not be optimally stimulated and optimal stimulation in the golgi tendon organ leads to an optimal stretching (Ahmed & Samhan, 2016). Good stretching of the muscles will make vasodilation in the blood vessels around the muscles so that blood flows smoothly. This can lead to a decrease in pain and an increase in the flexibility of the hamstring muscles (Kisner & Colby, 2017).

Working as a tailor has a high risk of decreased hamstring muscle flexibility caused by a static and poor sitting posture for a long time, so it is deemed necessary to increase muscle flexibility and reduce pain experienced by tailors. Research conducted by Castellote-Caballero et al. in 2013, involving 28 male soccer players, showed that a neurodynamic sliding intervention resulted in a brief increase in the hamstring flexibility. The study was limited by the small sample size, inclusion of young males only, and the involvement of control group that did not receive any treatment. Despite these drawbacks, the study provides evidence that neurodynamic therapy can significantly improve hamstring flexibility in young men. It also suggests that future studies compare neurodynamic methods with other interventions in larger populations. Therefore, a deeper study to strengthen the empirical evidence is required to know more about the effectiveness of the neurodynamic sciatic nerve slider technique and passive stretching technique on reducing pain and increasing flexibility of the hamstring muscles in tailors with short hamstring syndrome.

METHODS

This study used an experimental method with pre and post test two group design. The sampling method used in this research was purposive sampling. The study was conducted in Lestari Jaya Konveksi. Because tailors usually do long sitting activities, many tailors experience shortening of the hamstrings muscle. The sampling technique in this study used purposive sampling technique. The research and data collection were carried out from July 2022 - August 2022.

Participants

The target population of this study were all tailors at Lestari Jaya Convection. The feasible population for this study were tailors at Lestari Jaya Convection with short hamstring syndrome complaints based on the physiotherapy assessment carried out. The population of this study were 41 people selected using purposive sampling technique. The sample of this study were 22 people selected based on inclusion and exclusion criteria and physiotherapy assessment.

Sampling Procedures

Sampling was carried out based on inclusion and exclusion criteria. A total of 22 people received the neurodynamic sciatic nerve slider intervention and passive stretching intervention. The inclusion criteria of this study were positive subjects experiencing a decrease in hamstring muscle flexibility, unable to achieve knee extension above 160o in a 90o hip flexion position, willing to become research subjects from the beginning to the end of the study by signing an agreement to be a research sample, and aged 20 to 40 years. Exclusion criteria of this study were subjects experiencing herniated nucleus pulposus, an acute inflammation in the lower back, hip, knee and ankle, and having received other modalities or interventions. The determination of the number of sample in this study used the Pocock formula. The results obtained 22 people divided into 2 groups as shown in Table 1.

Materials and Apparatus

Pain, in this study, was measured using the Visual Analogue Scale (VAS). VAS validity is 0.84, meaning that it has high validity. The reliability value of the VAS is 0.77, meaning that the VAS has sufficient reliability (Boonstra et al., 2008). Measurement of hamstring muscle flexibility was carried out using active knee extension (AKE). The reliability value of the AKE includes: the interrater (test-retest) reliability ICC value is 0.78–0.97 and interrater reliability intraclass

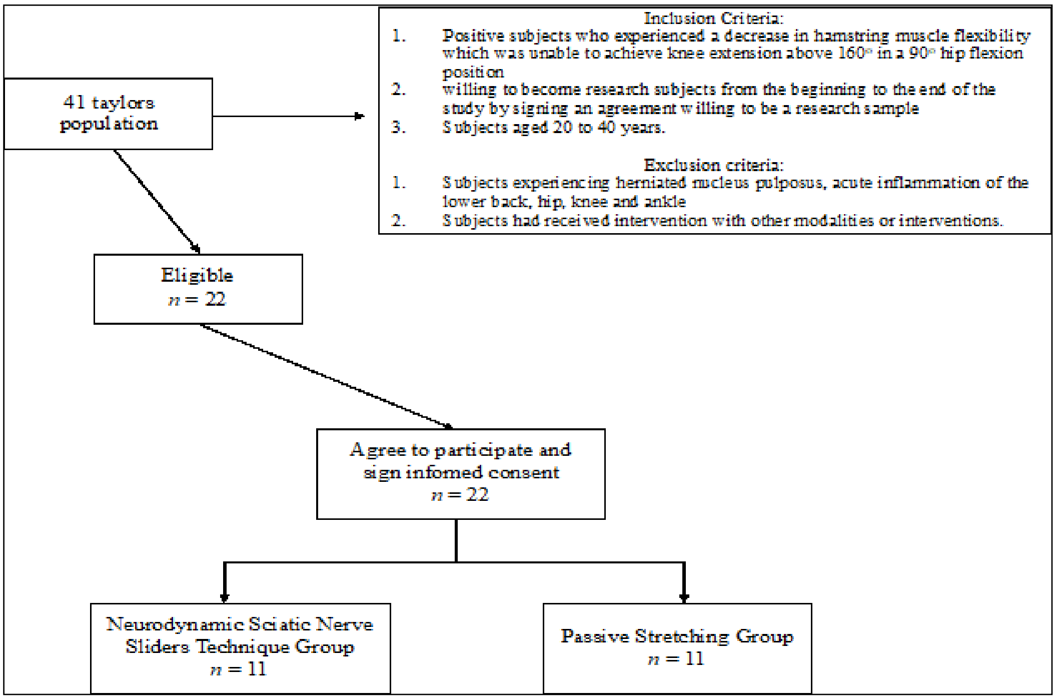

Figure 1. Flow Diagram of Subject Recruitment

Table 1. Research Group

Treatment	n	Group
Neurodynamic Sciatic Nerve Slider Technique	11	I
Passive Stretching Technique	11	II

correlation coefficients (ICC) is 0.87. The AKE test shows an excellent interrater and interrater reliability for assessing hamstring flexibility (Hamid et al., 2013).

Procedures

a) Before collecting data, the researcher explained the purpose and procedures of the research. The researcher also provided an opportunity for respondents to ask questions if there were things they did not understand.
b) Furthermore, the researcher asked for approval from the subject regarding the research to be carried out. After approval, the researcher handed over the informed consent sheet and consent sheet to the subject and asked for the subject signature on the sheet.
c) Then, interviews and examinations were conducted to obtain data on the subject characteristics regarding age.
d) Next, the pain and flexibility of the hamstring muscles were examined using VAS and AKE tests.
a) After examining and measuring hamstring muscle pain and flexibility and meeting the inclusion and exclusion criteria, the subjects were given neurodynamic sciatic nerve slider technique (for Group 1) and passive stretching exercises (for Group 2).
b) At the end of the training session, hamstring pain and flexibility were measured using the VAS and AKE tests.

Design or Data Analysis

The data analysis used in this study was SPSS version 25 software. Descriptive statistics for analyzing age were taken before carrying out the initial intervention. The normality test used the Shapiro-Wilk test to determine the normal distribution of the data. The data homogeneity test used Levene's Test aimed to determine the variation of the data. Paired samples t-test and independent t-test were conducted to test differences of the results before and after treatments with a significance level of $\alpha = 0.05$.

RESULT

To present a more complete research result and strengthen the interpretation of hypothesis testing, a description of the characteristics of the research sample is presented in tabular form. Table 2 presents a description of the age of the samples. Table 2 shows that the research subjects had an average age of 28.32 ± 2.19 years. Subject characteristics, based on gender, showed that there were 18 (81.81%) women and 4 (18.19%) men.

Table 2. Distribution of Sample Data

Characteristics	**Average Value and Standard Deviation**	
Age	28.32±2.19	
Gender		
Men	4	18.19 %
Women	18	81.81 %

Based on the results of the normality test the data were normally distributed. Similar with normality test, the results of the homogeneity test, the data were homogeneous. Based on Table 3, the results showed that the mean difference in VAS score reduction analyzed by paired sample t-test before and after the intervention in Group 1 gained a value of p = 0.000 (p <0.05), meaning that there was a significant difference in pain reduction before and after interventions. The result of the hypothesis testing before and after the interventions in Group 2, using the paired sample t-test, obtained a value of p = 0.000 (p <0.05), meaning that there was a significant difference in the decrease of pain before and after the intervention.

Table 3. Pain Reduction Mean Test Using VAS Before and After Interventions

	Pre	Post	Mean difference	95% Confidence Interval	95% Confidence Interval	p
			Mean difference	Lower		
Group 1	4.78	1.48	3.30 ±1,10	2.55	4.04	0.000
Group 2	4.40	2.37	2.03±0,97	1.37	2.69	0.000

Table 4. Flexibility Improvement Mean Test Using AKE Before and After Interventions

	Pre	Post	Mean difference	95% Confidence Interval	95% Confidence Interval	p
			Mean difference	Lower		
Group 1	133.64	165.0	31.36±4.22	28.52	34.20	0.000
Group 2	130.91	155.0	24.09±3.08	22.02	26.16	0.000

Table 5. Independent T-Test Results for Pain Reduction

	Group	n	Mean ± Standard Deviation	95% Confidence Interval Lower	95% Confidence Interval Upper	p
Pre	Group 1	11	4.78±0.81	-0.33	1.07	0.284
	Group 2	11	4.40±0.77			
Post	Group 1	11	1.48±1.10	-1.73	-0.049	0.039
	Group 2	11	2.37±0.76			
Difference	Group 1	11	3.30±1.10	0.33	2.19	0.010
	Group 2	11	2.03±0.76			

Table 6. Independent T-Test Results for Increased Flexibility

	Group	n	Mean ± Standard Deviation	95% Confidence Interval Lower	95% Confidence Interval Upper	P
Pre	Group 1	11	133.64±5.51	-2.88	8.33	0.323
	Group 2	11	130.91±7.00			
Post	Group 1	11	165.00±4.05	4.17	15.82	0.002
	Group 2	11	155.00±8.33			
Difference	Group 1	11	31.36±4.05	3.98	10.56	0.000
	Group 2	11	24.09±8.33			

Based on Table 4, the results showed that the mean difference in the increase of the AKE score analyzed by paired sample t-test before and after the intervention in Group 1 obtained a value of p = 0.000 (p <0.05), meaning that there was a significant difference in the increase of flexibility before and after interventions. The hypothesis testing before and after the intervention in Group 2, using the paired sample t-test, obtained a value of p = 0.000 (p <0.05), meaning that there was a significant difference in the increase of flexibility before and after the intervention.

Based on Table 5, showing the result of independent t-test on pain reduction, the value of p = 0.010 (p <0.05) after treatment was obtained. It means that there was a significant difference of reduced pain in the intervention Group 1and Group 2. Based on Table 6, showing the result of independent t-test on increased flexibility, the value of p = 0.000 (p <0.05) after treatment was obtained. It means that there was a significant difference of increased flexibility in the intervention Group 1 and Group 2.

DISCUSSION

In this study, the average age of the samples was 28.32 ± 2.19 years. Hamstring muscle strain and the problems can have an impact on a person social life. Aging causes muscle mass and its functional ability deteriorate because muscle fibers and muscle mass are decreasing. The prevalence of short hamstring syndrome often occurs in administrative professions because employees spend more sitting time at work. The results of this study are in line with the research conducted by Daga et al., 2021, concluding that older soccer players have a lower level of hamstring muscle flexibility than younger soccer players (Daga et al., 2021). Decreased hamstring flexibility due to aging can be caused by biological changes, such as changes in the joint capsule, changes in the muscles, and tendon stiffness. Statistical significant loss of hamstring muscle length occurs with age. The decrease of flexibility is largely due to the loss of elasticity of the connective tissue surrounding the muscles that undergo the normal shortening process. The decrease in joint range of motion and muscle flexibility with aging may be caused by age-related molecular cross-links in the collagen molecule that have the potential to change the mechanical characteristics of collagen at the cellular level (Mistry et al., 2014). In addition, this decrease is triggered by reduced growth hormone secretion by the pituitary gland so that the ability of tissue recovery is slowing down. Growth hormone in humans reaches its peak at the age of 20-25 years and will decrease drastically in the elderly. A person lack of activity will affect the flexibility. It happens because the soft tissues and joints shrink so that they lose muscle tension; if a person is not active, the muscles are maintained in a shortened position for a long time (Daga et al., 2021).

Subject characteristics, based on gender, showed that there were 18 (81.81%) women and 4 (18.19%) men. These results indicate that there were more women tailors than men at Lestari Jaya Konveksi. This research is in line with the research conducted by Aprilia et al. in 2021 which found that women were more dominant than men in tailors.

Neurodynamic Sciatic Nerve Slider Technique to Reduce Pain and Increase Hamstring Muscle Flexibility in Tailors

Flexibility is the ability to perform movements easily, without limitations and free from pain within the range of motion. Flexibility is related to good elongation of the musculotendinous unit (Kisner & Colby, 2017). Postural habits, or postures a person adopts throughout the day, are closely related to impaired postural function, such as sitting. When sitting, the hamstring muscles will experience pressure, causing damage. Muscle Spindles and Golgi Tendon Organs, which function as stretch receptors in contractile tissue, are in direct contact with damaged elastic tissue in muscles. The level of muscle work in a static position, when there is a change or damage to the elastin structural components, will give an impact that muscle tension will be responded to by changing the muscle length. The muscle tension will then adapt the condition of the muscles contracting statically. The golgi tendon which functions as a tension detector (muscle tension) during muscle contraction or muscle stretching will receive signal transmission as a result of the adaptation conditions carried out by the muscle stretch. If it lasts too long, the tension will adversely affect the contractile tissue. The result is the shortening of the contractile tissue affecting the flexibility of the hamstring muscles (Miucin et al., 2020).

Overuse of motor units in the long term will result in the accumulation of metabolic wastes, which will alter the calcium ion homeostasis in the muscles. Muscle cell membranes will experience autogenic damage due to this disease. This membrane damage results in leakage of intracellular lactate dehydrogenase, damage to mitochondria of muscle cells, loss of energy in muscle cells, and pain due to the release of IL-6 and other cytokines (Baird et al., 2012). This damage also results in damage to the myofilaments in the muscles, which in turn results in damage to the muscle fibers. Damage to myofilaments will result in pain in the muscles as a feeling of tension (tightness), which will result in restrictions on muscle movement (Miucin et al., 2020).

Mechanosensitivity, the sensitivity of the nerves to movement, can contribute to pain during movement or changes in body position. It can be caused by mechanical or physiological disturbances in the nerves. Recurrent injuries may result from abnormalities in nerve mechanosensitivity (Sharma et al., 2016). Nerve mobilization interventions are used to restore the mechanical and physiological reactions of the nervous system to normal movement and posture. Nerve mobilization can result in complex neurophysiological changes that facilitate nerve function and relieve symptoms. These changes include changes in nerve viscoelastic properties, mobility, and intraneural fluid dispersion as well as reduced activation of pain-inhibiting mechanisms and concentrations of inflammatory mediators that cause nerve pain (Cadellans-Arróniz et al., 2021).

The concept of neurodynamics, which links the mechanics and physiology of the nervous system and combines them with musculoskeletal function, suggests that neurodynamic procedures improve the functional status of patients and was shown to be superior in all the results of previous studies. The acidic environment of fluids and cells includes enzymes found in inflamed nerves, involving prostaglandins, histamine, and macrophages. This can increase the sensitivity of the peripheral nerves causing pain (Ahmed & Samhan, 2016). The neurodynamic sliding technique reduces pain and inflammation by reducing increased endoneurial fluid pressure. It increases local breakdown of inflammatory products in and around nerves and reduces antidromic impulses generated in C fibers at dysfunctional sites, resulting in the release of neuropeptides and reduced inflammation in the tissues supplied by nerves. Sensory nerves present in the connective tissue of the peripheral nerves that provide nociception and proprioception. Stretch receptors are activated by movement and act as a protective mechanism for the nervous system. Nerve mobilization has been shown to decrease the sensitivity of these receptors, thereby increasing tolerance to the pain threshold (Moksha et al., 2019).

Passive Stretching to Reduce Pain and Increase Hamstring Muscle Flexibility in Tailors

The results of this study are in line with the research conducted by Monayo & Akuba in 2019, stating that stretching exercises had the effect on reducing the knee joint pain scale in Osteoarthritis patients. Stretching involves stretching the muscles to increase the flexibility of joints and muscles. Stretching is good at increasing the flexibility of joints and muscles to reduce or eliminate pain. According to Ginting et al., (2022), this activity can help improve blood flow and strengthen bones. The benefit of stretching exercises is to increase physical fitness by facilitating the transportation of substances the body needs and removing the remains of substances that are not needed by the body. The stretching stimulus will reach the brain first so that it closes the pain gate so that the perception of pain does not appear; with regular exercise, it can provide benefits for body fitness and joints to move well, especially in the ability to mobilize (Kurniawan et al., 2023).

In general, passive stretching exercises are stretching exercises that are carried out by maintaining a stretched position for a long time performed slowly and not in a hurry (Kisner & Colby, 2017). This slow movement is intended to prevent the muscle spindles to strecth. The muscle response to passive stretching of the hamstring muscles depends on the structure of the muscle spindle and golgi tendon organs, when the hamstring muscles are stretched quickly, the primary afferent fibers stimulate α (alpha) motor neurons in the spinal cord and facilitate extrafusal fiber contraction, which increases tension in muscles (Kisner & Colby, 2017). The probable cause of the reduced pain is that stretching the muscle while maintaining this position for the duration determined by the investigator facilitates muscle spindles. The longer the muscle spindle stretches, the more the muscles will adapt. Passive stretching is performed until the sample feels pain. After the sample feels pain, it is given more stretch. When the muscle spindle reflex is activated, it is in an extended position so that the muscle spindle gets used to the new muscle length. The muscle spindles trigger the stretch reflex and are gradually trained to provide even more stretching. It is the elongation of this muscle that increases the flexibility of the weakened hamstring muscles (Monayo & Akuba, 2019).

Passive stretching is a stretching technique performed manually by a therapist where the patient is relaxed. If the stretching force is done repeatedly and regularly, the muscles will gradually elongate. The mechanical response that occurs when a muscle is stretched causes the myofibrils and sarcomeres of the muscle to elongate, thus passive stretching is a good way to increase the flexibility of the hamstring muscles. When a muscle is stretched passively, the elastic parts (sarcomeres) initially elongate and the muscle contracts. After that, each sarcomere will return to its resting length position when the stretching force is released. If the stretching force is performed repeatedly and regularly, the muscles will gradually elongate (Kisner & Colby, 2017).

The results of this study are the similar to the results of a study conducted by Kurniawan, et al., (2023), stating that giving passive stretching to patients with genu osteoarthritis was effective in changing the flexibility of the hamstring muscles. In this study, it was said that the lower the intensity of stretching, the longer the body and tissues will tolerate stretching. The high intensity of stretching with a lower frequency can be used for tissue healing and reduce muscle soreness. Low stretching intensity with low duration is the safest form of stretching with the most significant results (Kisner & Colby, 2017). The effectiveness of a stretch is usually reported as an increase in joint ROM. For example, knee or hip ROM is used to determine changes in hamstring length. Static stretching often results in an increase in joint ROM. Interestingly, the increase in ROM may not be due to an increase in muscle length (decreased tension). Otherwise, the subject may simply have an increased tolerance for stretching. The increase in muscle length is measured by "extensibility", usually where a standard load is placed on the extremity and joint motion is measured. The increase in tolerance to stretching is measured by measuring the range of motion of the joint under a non-standard load. Chan and colleagues demonstrated that 8 weeks of static stretching increased muscle extensibility. However, most studies of static stretching training show increased ROM due to increased stretch tolerance (ability to withstand more stretching force), not the extensibility or increased muscle length (Page, 2012).

Neurodynamic sciatic nerve slider technique compared to passive stretching in reducing pain and increasing hamstring muscle flexibility in tailors with short hamstring syndrome

The ideal strength-length relationship between the hamstring muscles is important from a functional point of view. The hamstring muscles are prone to small injuries, especially during vigorous eccentric loads, which gradually decrease stretch tolerance. If left unchecked, this can increase the risk of hamstring strain injuries, causing pain and decreasing the flexibility of the hamstring muscles (Ragia et al., 2021). Mechanosensitivity, the sensitivity of the nerves to movement, can contribute to the pain during movement or changes in body position. It can be caused by mechanical or physiological changes in the nerves. Recurrent damage to nerves can result from abnormalities in their mechanosensitivity (Ragia et al., 2021). The movement causes an increase in interneural tension. The mobility of the neural network is affected by the network interface, but normal neural function or movement is required to control the interface. Nerve mobilization is provided by moving the nerve tissue repeatedly to change the vascoelasticity of the muscle tissue. In addition, the facilitation provided causes a decrease in mechanosensitivity in the nerves (Sharma et al., 2016).

Nervous tissue will experience adaptation to neurodynamic training. According to the neurophysiological impact of spinal cord mobilization, active sympathetic nerves will increase blood flow to the muscles and stimulate them more quickly, especially the nerves that innervate the leg muscles (Kisner & Colby, 2017). The neurodynamc sliding technique reduces pain and inflammation by reducing increased endoneurial fluid pressure. It can increase local breakdown of inflammatory products in and around nerves and reduce antidromic impulses generated in C fibers at dysfunctional sites, resulting in the release of neuropeptides and reduced inflammation in the tissues supplied by nerves (Ragia et al., 2021). An increase in tissue temperature also occurs in a stretched muscle. The leg that was not stretched showed a slight decrease in skin temperature, while the leg that was stretched showed an increase, thus exhibiting a significant vasodilator effect. Therefore, it concludes that neurodynamics may have a sympathetic inhibitory effect, which may be a physiological mechanism. In addition, the neurodynamic sciatic nerve slider technique can affect the extraneural interface. At the extraneural interface, where adhesions occur between the neural tissue and its surroundings, can limit the passage of the neural tissue within the mechanical interface and can increase tension during passive stretching (Ahmed & Samhan, 2016). The reported analgesic effect of neurodynamic mobilization on reducing the onset of pain perception is another explanation for the increased flexibility observed. Sensory theories, that do not deal with direct analgesia but rather with a person experience in stretching or discomfort (stretch tolerance) as a result of improved neurodynamic functioning, have been described as having a similar effect. It is not known whether this change in stretch tolerance is a peripheral, central, or combined event (Babu et al., 2015).

The neurodynamic sciatic nerve slider technique in the supine position causes stretching of the nerves in the hips and knees, as well as relaxation in the ankles. It has been shown that passive flexion of the hip produces caudal loading of the lumbosacral and sciatic nerve roots in the hip, followed by extension of the hip. During hip extension, there is a discharge of these neural networks, and they move in a cranial direction. Hip flexion and lumbar flexion lead to opening of the intervertebral foramina and central canal further facilitating caudal movement of neural structures. Movement of these neural structures can be effective in breaking down intraneural edema, thereby restoring the pressure gradient and eliminating hypoxia (Moksha et al., 2019). Decreased pain and increased flexibility of the hamstring muscles are also implicated because the neurodynamic sciatic nerve sliders technique can reduce increased endoneurial fluid pressure, increase the breakdown of local inflammatory products in and around the nerve, and reduce antidromic impulses generated in C fibers in dysfunctional locations resulting in the release of neuropeptides and reduced inflammation in the tissues supplied by the nerves (Shinde & Kanase, 2017).

The slow passive stretching movement is intended to prevent the muscle spindles to stretch and facilitate the muscle spindles to adapt to the applied stretch force. The muscle response to passive stretching in the hamstring muscles depends on the structure of the muscle spindle and golgi tendon organs; when the hamstring muscles are stretched quickly, the primary afferent fibers stimulate α (alpha) motor neurons in the spinal cord (Vakhariya et al., 2016). Neurodynamic sciatic nerve slider technique provides improvements to the structure of the nerves and the interface tissue around the nerves and stretches the hamstring muscles. The neurodynamic sciatic nerve slider technique can be said to reduce pain and increase the flexibility of the hamstring muscles. While passive stretching can only facilitate the muscle spindles to adapt to reduce pain and increase the flexibility of the hamstring muscles.

The implementation of this research certainly has limitations. It is recommended that next research not only use AKE and VAS, but other more objective instruments. Later studies may compare neurodinamic interventions with other interventions and employ larger sample sizes. Besides that, this study only examined the immediate effects of a single episode, thus follow-up should be considered since it is not known how long the observed increase in hamstring flexibility might have lasted.

CONCLUSION

The research findings conclude that the neurodynamic sciatic nerve slider technique and passive stretching technique can reduce pain and increase the flexibility of the hamstring muscles in tailors with short hamstring syndrome .

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