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Original Research

Effects Of Lower Limb Neurodynamic In Short Hamstring Syndrome

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ABSTRACT

Background: *Injury to the hamstring muscle is a very common site of injury in general sports or work-related physical activity. The purpose of this study was to compare the effectiveness of the addition of lower limb neurodynamics to the intervention of ultrasound therapy and stretching in short hamstring syndrome.*

Methods: *This study is a Randomized Controlled Trial with a Pre-Test and Post-Test Group Design. The number of subjects in this study was 30 respondents, who were divided into 2 groups, namely the control group (n = 15) and the treatment group (n = 15). In the control group, subjects received a combination of ultrasound therapy and stretching. In the treatment group, subjects received a combination of ultrasound therapy, stretching, and lower limb neurodynamics. The intervention was carried out three times a week for four weeks (12 sessions). The length of the hamstring muscles is measured by straight leg raise (SLR) range of motion (ROM) and passive knee extension (PKE) ROM using a goniometer.*

Results: *The results of statistical analysis showed that there was a significant difference between the two groups in the difference between the SLR ROM and PKE ROM before and after the intervention measured using a goniometer (p = 0.000).*

Conclusion: *The addition of lower limb neurodynamics in the combination of ultrasound therapy and stretching intervention is proven to increase SLR ROM and PKE ROM in cases of the short hamstring. Lower limb neurodynamics could be used in clinical practice as an alternative to improving short hamstring syndrome.*

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INTRODUCTION

An injury to the hamstring muscle is a very common site of injury in general sports or work-related physical activity. The number of hamstring injuries has not decreased in recent times, and the recurrence rate is very high. Studies show the peak of hamstring injuries occurs at the age of 16 to 25 years. Research in Europe on a population of soccer athletes shows that at least every year there is an increase in the number of cases of hamstring injuries by 2.3%. Hamstring injuries are more common in older athletes than younger athletes (Poudel & Pandey, 2022).

The flexibility of the hamstring muscles is the basis for good movement and function in any sport. This muscle group imbalance is often caused by the dominance of the stabilizing muscle or muscle group over the muscle or muscle group that moves it. In the latest developments in physiotherapy, several physiotherapy techniques can be used to reduce muscle tension in certain muscle groups. This shortening condition often occurs in the hamstring muscle group, which is often called Short Hamstring Syndrome (SHS) (Balcı et al., 2020; Razouvohu & Ganesh, 2017; Sadek et al., 2021).

SHS is one of the risk factors for non-contact injuries. SHS is capable of causing injuries to athletes, such as football, futsal, or basketball. SHS often causes injuries to the legs and also leads to hip and spine problems (Gene-Morales et al., 2021; Owoeye et al., 2020). Currently, the valid SHS examination techniques are the Straight Leg Raise (SLR) Test and the Passive Knee Extension (PKE) Test. This examination should be carried out by a physiotherapist, and if SHS is found, it should be treated immediately to prevent a reversal of the condition and injury (Hansberger et al., 2019; Liu et al., 2022).

In a recent study on stretching techniques, one of the techniques, namely active stretching, was able to reduce hamstring muscle tension. Active stretching is a type of self-stretching, where the stretching technique is carried out by the patient or client himself without the aid of tools or a physiotherapist (Amin et al., 2015; Page, 2012). Stretching techniques are also often combined with other physiotherapy interventions, such as ultrasound therapy. The latest results from this study show that the addition of ultrasound therapy is very effective at producing better results than stretching alone (Piqueras-Rodríguez et al., 2016).

Research shows that there is a change in the structure of the sciatic nerve, namely the shortening of the length of the hamstring muscle. Neurodynamics is an intervention that can increase the mobility of the nervous system. Increasing the neural excursion, it can be done by using tension and slider techniques. Neurodynamics in the lower extremities has been shown to increase the range of motion of the joints in knee extension and hip flexion in some cases of limited ROM (Balcı et al., 2020; Razouvohu & Ganesh, 2017; Sadek et al., 2021).

The purpose of this study was to compare the effectiveness of Lower Limb Neurodynamic and Ultrasound Therapy to Hamstring Stretching and Ultrasound Therapy in increasing ROM in SHS.

MATERIALS AND METHOD

Research with a Randomized Pre-Test and Post-Test Group Design. The study was conducted on subjects who had short hamstring syndrome from July to October 2019 at the Physiotherapy Independent Practice in Denpasar City. This study included informed consent, and the principles stated in the Helsinki Declaration have been fulfilled.

The target population in this study was all samples indicated to have short hamstring syndrome. The affordable population in this study was the sample indicated to have short hamstring syndrome who visited the Physiotherapy Independent Practice in Denpasar City. Subjects were selected using inclusion, exclusion, and drop-out criteria. Inclusion criteria included: (1) being willing to be a research subject from beginning to end by signing a consent letter; (2) Having bilateral SHS (both legs); (3) Not doing sports while being a sample, and (4) being aged 18–30 years.

Exclusion criteria included: (1) acute muscle and/or ligamentous injury; (2) recent or poorly connected fractures; (3) ligamentous hyperlaxity; and (4) Marfan syndrome or functional shortening. The drop-out criteria include: (1) the sample withdrew; (2) if, during data collection, the patient suddenly fell ill or was injured for some reason; and (3) the patient did not participate in the exercise more than three times.

The number of subjects in this study was 30 respondents, who were divided into 2 groups, namely the control group (n = 15) and the treatment group (n = 15). In the control group, subjects received a combination of ultrasound therapy and stretching. In the treatment group, subjects received a combination of ultrasound therapy, stretching, and lower limb neurodynamics. The intervention was carried out three times a week for four weeks. The results of the therapy evaluation were measured by the length of the hamstring muscles as measured by ROM straight leg raise (SLR) and passive knee extension (PKE) using a goniometer.

Ultrasound therapy is applied by applying a gel to the skin and the surface of the transducer. The applied UST dose includes: frequency (1 MHz), intensity (0.4 W/cm^2), pulse ratio (1:3), treatment area (3 transducers), and duration (12 minutes), and does increase due to energy loss due to the target depth of about 0.70 W/cm^2. Stretching is a technique for lengthening the contractile and non-contractile tissues of the muscle-tendon units and periarticular structures. Stretching is a major intervention in cases of muscle shortening and tension.

In this study, stretching was performed on the hamstring muscles by moving the patient's lower leg towards hip flexion while keeping the patient's knee in an extended position. This hamstring stretching is done passively for 3 sets, where each set is held for 12 seconds, followed by 30 seconds of rest between sets. Stretching was done three times a week for a total of four weeks of treatment.

Lower limb neurodynamics is a physiotherapy intervention approach that aims to improve the mechanical function of nerves to move between their mechanical interfaces. The techniques given to lower limb neurodynamics include the slider technique and the tensioner technique to increase the movement of nerve structures around the mechanical interface. The lower limb neurodynamic technique is performed by moving the lower leg in the following directions: hip flexion, knee extension, ankle dorsiflexion, leg eversion, and toe extension, followed by cervical flexion sequentially. This technique is done passively with a physiotherapist providing dynamic repetitive movements for 5 minutes per set, performed in 2 sets with a 60-second rest interval between sets. The frequency of this therapy is three times a week for four weeks.

SLR ROM measurements were performed with the patient in a supine position, then the examiner moved the sample's lower leg in the direction of hip flexion by keeping the knee in extension until it reached the maximum limit of movement indicated by muscle tension. PKE ROM measurements were carried out with the patient still in a supine position, with the hip flexed at 900 and the knee in flexion. Then the physiotherapist moved the patient's knee toward extension until it reached the maximum limit of movement, which was also marked by muscle tension. The ROM is measured using a goniometer, whose value is obtained in degrees (^{o}).

The research flow includes (1) an application for research permission at the research institution; (2) Researchers submitting ethical clearance to the Research Ethics Commission, Faculty of Medicine, Udayana University/Sanglah Central General Hospital; (3) Signing informed consent by the subject; (4) The researcher explaining to the subject under study the benefits, objectives, how this research was conducted, and the importance of this research; (5) After the examination, the subjects were grouped into two parts, namely the control group and the treatment group. Before and after the intervention, both groups measured ROM in straight leg raises (SLR) and passive knee extensions (PKE) using a goniometer. After 12 evaluations and obtaining complete data, the researchers compared the results before and after the intervention in the two treatment groups and conducted a different test between the two groups with SPSS software.

RESULTS

To describe the research results more fully and strengthen the interpretation of hypothesis testing, a description of the data in the form of the characteristics of the research sample is presented in tabular form. The following is a description of the sample characteristics based on gender, age, and body mass index.

Table 1. Distribution of Respondents Characteristics in Control and Treatment Groups

Characteristics	Control Group (n=15)	Treatment Group (n=15)
Sex *ƒ* (%)		
Male	10 (66.7)	8 (53.33)
Female	5 (33.3)	7 (46.7)
Age (years)		
Mean ± SD	23.87±3.07	24.80±3.44
Body Mass Index		
Normal	9 (60)	8 (53.33)
Overweight	6 (40)	7 (46.7)

Table 1 shows that in the control group, there were 10 male samples (66.7%) and 5 female samples (33.3%). In the treatment, there were 8 male subjects (53.3%) and 7 female subjects (46.7%). This shows that the incidence of short hamstring syndrome is higher in men than women. This data follows research by Golhar et al., (2017), which shows that the incidence of short hamstring syndrome is more common in men than women (Golhar et al., 2017). The study by Shakya & Manandhar, (2018) is also a descriptive description of this study, which showed a higher prevalence of short hamstring syndrome in men compared to women (Shakya & Manandhar, 2018).

Research subjects in the control group had a mean age of 23.873.07 years with a median value of 24.00, with the lowest age being 19 years and the highest age being 29 years. In the treatment group, the group had an average age of 24.83.44 years with a median value of 26.00, with the lowest age being 19 years and the highest age being 30 years. This shows that short hamstring syndrome is more prevalent in young adults, who tend to have a fairly high level of activity. The data in this study follow the descriptive data described by a study conducted by Castellote-Caballero, which showed that the age of the sample who experienced the shortest hamstring syndrome was 20 to 25 years (Castellote-Caballero et al., 2014).

In the control group, 9 subjects (60.0%) had normal BMI and 6 (40.0%). In the treatment group, 8 subjects (53.3%) had a normal BMI, and 7 (46.7%) had a normal BMI. The increase in BMI did not significantly affect the incidence of short-hamstring syndrome. To find out whether the data is normally distributed and homogeneous, the normality test and the homogeneity test are carried out. The normality test was carried out using the Shapiro-Wilk test, while the homogeneity test was carried out using Levene's test. The results of the analysis are listed in Table 2.

Table 2. Normality and Homogeneity test

Data Group	Normality test[a]		Homogeneity test[b] (p value)
	Control group (p value)	**Treatment group (p value)**	
ROM SLR (pre-test)	0.067	0.105	0.976
ROM SLR (post-test)	0.370	0.471	0.753
ROM PKE (pre-test)	0.105	0.105	0.339
ROM PKE (post-test)	0.071	0.692	0.281

a Shapiro Wilk- test ; b Levene's Test

Based on Table 2 the results of the normality test using the Shapiro Wilk test obtained a probability value for the data group before the intervention in the control group where the p-value in the SLR and PKE measurements was obtained at ($p>0.05$) both before and after the intervention and in the treatment group, p-values on SLR and PKE ROM measurements were also obtained at ($p>0.05$) both before and after the intervention. These results indicate that the control group and the treatment group have data that is normally distributed. In the homogeneity test using Levene's test, a p-value > 0.05 was obtained for the measurement of ROM, SLR, and PKE before and after the intervention. This shows that the data before and after the intervention are homogeneous. Based on the results of the normality test and homogeneity test, the test used for hypothesis testing is a parametric statistical test.

Table 3. Analysis Results of Neck Pain and Disabilities Score

Data Group	Pre-test	Post-test	Difference	Paired t-test	Independent t-test
	Mean±SD	**Mean±SD**	**Mean±SD**	**p value**	**p value**
ROM SLR					
Control group	54.60±4.08	74.67±4.15	20.07±1.44	0.000	0.000
Treatment group	55.13±4.37	85.80±4.54	30.67±1.84	0.000	
ROM PKE					
Control group	21.93±2.12	12.00±2.20	10.07±0.46	0.000	0.000
Treatment group	22.67±1.80	3.40±1.35	19.13±0.91	0.000	

From the calculation of the increase in SLR ROM measured using a goniometer before and after the intervention calculated using a paired sample t-test in the control group, p = 0.000 ($p < 0.05$) and p = 0.000 ($p < 0.05$) in the treatment group (Table 3). In the control group, the mean increase in SLR ROM measured using a goniometer after the intervention was 74.67±4.152. In the treatment group, there was an increase in SLR ROM after the intervention to 85.80 ± 4,539.

The results of statistical analysis showed that there was a significant difference between the two groups in the difference in SLR ROM measurements before and after the intervention, measured using a goniometer, with a p-value of 0.000 (20.07±1.438 in the control group and 30.67±1.839 in the treatment group). Thus, it can be concluded that the addition of lower limb neurodynamic intervention improved SLR ROM more than the intervention of ultrasound therapy and stretching of the hamstring alone in patients with short hamstring syndrome.

Table 3 shows the results of the calculation of the average difference in the increase in PKE ROM as measured using a goniometer. In the control group given the intervention of ultrasound and hamstring stretching, an increase in ROM after the intervention was found to be 12.00 ± 2,204, while in the treatment group that received the intervention, namely the addition of lower limb neurodynamic to the intervention of ultrasound and stretching the hamstring, an increase in PKE ROM after the intervention was obtained to be 3.40 ± 1,352. Based on the results of statistical tests using a paired sample t-test, we obtained a p-value of 0.000 ($p<0.000$) in the control group and a p-value of 0.000 ($p<0.000$) in the treatment group, which means ultrasound intervention, hamstring stretching, and the addition of the lower limb neurodynamic are effective in increasing PKE ROM in cases of short hamstring syndrome.

The results of statistical analysis using the independent sample t-test showed that there was a significant difference between the two groups in the difference between the ROM PKE measurements before and after the intervention measured using a goniometer with a p-value of 0.000 (10.07±0.458 in the control group and 19.13±0.915 in the control group and 19.13±0.915 in the control group). Thus, it can be concluded that the addition of lower limb neurodynamic intervention increased PKE ROM more than ultrasound intervention and stretching the hamstring alone in patients with short hamstring syndrome.

DISCUSSION

In this study, the results showed that both hamstring stretching and lower limb neurodynamics were proven to increase the flexibility of the hamstring muscles as measured using a goniometer in SLR and PKE ROM. When compared between the two groups, it was found that the group that received the lower limb neurodynamic intervention improved SLR and PKE ROM more than the hamstring stretching alone. Several studies have shown that passive stretching in short hamstring syndrome has an effect on increasing the range of motion of the joints and the flexibility of the associated tissues (Desai et al., 2018; Heshmatipour et al., 2019; Nishikawa et al., 2015).

The combination of stretching and ultrasound therapy increases flexibility in SHS (E. Ahmed et al., 2014; Cho & Kim, 2016; Kumari & Agarwal, 2021). The heating effect provides local heat, resulting in vasodilation of blood vessels and increased blood circulation to the area that can be absorbed properly and help treat muscle spasms. The heat generated and the movement of the transducer provide a sedative effect. It helps to reduce pain (Asri et al., 2016). Another study stated that ultrasound therapy facilitates flexibility in SHS by increasing blood flow, increasing the extensibility of collagen tissue, and localizing metabolism (Monisha, 2018).

The study of the most optimal intervention technique to improve muscle flexibility is still a widely debated topic. It was concluded that contractile tissue is not the only soft tissue that causes limitation of movement, but also non-contractile tissue that has involvement in the limitation of motion, such as deep fascia, soft tissue around joints, and even neurological tissue such as peripheral nerves, can limit the range of motion (Page, 2012; Stecco et al., 2020). In this study, SLR movement, consisting of hip flexion accompanied by knee extension and ankle dorsiflexion, is often used as a measurement to determine the level of flexibility of the hamstring muscles.

Movements consisting of these components not only result in the stretching of the hamstring muscles but also result in major stretching of the peripheral nerve structures that are attached from the proximal end of the spinal cord to the distal end of the innervated tissue, such as the toes. The results of this study are in line with the results of research conducted (Ahmed et al., in 2016). In his research, Ahmed compared neurodynamic intervention with static stretching to increase hamstring muscle flexibility in 40 healthy male subjects. The results of this study showed that the increase in flexibility of the hamstring muscles as measured by the SLR was greater with the provision of neurodynamic intervention when compared to static stretching (A. R. Ahmed & Samhan, 2016).

A recent study involving 52 subjects analyzed the effectiveness of neural mobilization on hamstring tightness in the low back pain population. This study proves that neural mobilization is proven to reduce pain, improve disability, and increase SLR ROM in the low back pain population with SHS. Providing a lower limb neurodynamic or neural mobilization intervention can further increase SLR ROM due to an increase in tension in the nervous structure. It affects the scope of neural excursions and can increase SLR movement (Patel et al., 2020).

Vakhariya et al., (2016) compared the effects of various types of intervention approaches on increasing hamstring muscle flexibility in cases of short hamstring syndrome. A total of 80 samples were included in this study with an age range of 18 to 25 years, which were divided into 4 different groups, namely: the suboccipital muscle inhibition (SMI) group, the neurodynamic stretching (NDS) group, the static stretching group, and the control group with measurements of SLR, PKE, and the modified sit-and-reach test. Based on statistical analysis, it was found that the group that received the NDS showed a more significant increase in flexibility when compared to the other three groups (Vakhariya et al., 2016).

When tension is applied to the nervous system during lower limb neurodynamic application, there is a reduction in cross-sectional area and an increase in pressure on the nerve, resulting in movement of the sciatic nerve along with the hamstring muscles, resulting in increased flexibility (Jeong et al., 2016; Thomas et al., 2021; Vinod Babu, 2015).

CONCLUSION

The addition of lower limb neurodynamics in the combination of ultrasound therapy and stretching intervention is proven to increase SLR ROM and PKE ROM in cases of short hamstring syndrome. Some of the limitations of this study include the lack of follow-up measurements. Future research is expected to be able to conduct follow-up studies to determine the long-term effects of adding lower limb neurodynamics on short hamstring syndrome.

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