

Effects of Slider, Tensioner Neurodynamic Mobilization Techniques and Stretching Exercises in patient with Chronic Discogenic Sciatica: A randomized, single blinded Comparative Study

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Abstract

Objective: To compare the effectiveness of the slider, tensioner neurodynamic mobilization techniques and stretching exercises on pain, ROM, and functional disability in patients with chronic discogenic sciatica.

Design: A pre-test post-test three-armed comparative study design

Setting: Outpatient clinics, faculty of physical therapy, Kafrelsheikh University

Participants: 36 patients with unilateral chronic discogenic sciatica were randomly allocated into three equal groups:

Group (A) slider neurodynamic mobilization

Group (B) tensioner neurodynamic mobilization

Group (C) stretching exercises of back extensors, hamstrings, and gastrocnemius muscles

Treatment was given three sessions per week for two weeks.

Outcome measures: all patients were examined by Visual Analogue scale (VAS) for pain intensity, Modified-Modified Schober test (MMST) for lumbar flexion ROM, Goniometer for hip flexion and knee extension ROM, and Oswestry Disability Index (ODI) for functional assessment.

Results: there were no statistically significant differences between groups at baseline ($p < 0.05$). There were statistically significant differences in the slider and tensioner groups compared to the stretching group for all variables. Furthermore, statistically significant differences were found in the slider technique as compared to the tensioner technique regarding ROM of lumbar flexion ($p = 0.03$), hip flexion ($p = 0.004$), and knee extension ($p = 0.005$).

Conclusion: Slider and tensioner neurodynamic mobilization techniques are more effective than stretching exercises in terms of reducing pain, increasing ROM, and improving function. Slider technique is more effective in ROM improvement.

1. Introduction

Low back pain (LBP) and sciatica has a growing clinical interest for many people due to their consequences on personal behavior and productivity at work (1). Sciatica refers to a set of symptoms including pain, numbness, muscular weakness, and movement limitations due to compression and irritation of the sciatic nerve. Pain is usually felt in the lower back, buttocks, and several dermatomes of affected thigh, leg, and foot (2). It affects many people, and its related disabilities disturbs their lives (3). Sciatica affects females more than males and affects people with sedentary lifestyle more than active

ones (4). It may appear either suddenly with aggressive activity or gradually, and in most cases, it is unilateral (5).

Sciatica may be caused by disc bulge or herniation, lumbar canal stenosis, spondylolisthesis, trauma, piriformis syndrome, and spinal tumors (6). In about 90% of cases, sciatica results from sciatic nerve compression due to disc herniation (7). Discogenic sciatica may be accompanied by LBP of variable intensity. Increased pain with coughing, sneezing, straining, or other forms of the Valsalva manoeuvres indicate a disc lesion (5). Nerve root compression due to disc herniation induces nerve inflammation and decreases nerve blood flow, which accumulates inflammatory mediators and induces pain (8, 9). Furthermore, there is block of neural conduction, oedema, and mechanical sensitization (10).

Physiotherapy is considered a golden standard for treatment of sciatica (11). Neurodynamic mobilization can greatly reduce inflammatory mediators and consequently pain after sciatic nerve compression (12). Furthermore, mobilization of the sciatic nerve, after experimentally induced sciatica in rats, reduced intraneural oedema and adhesions and finally recover nerve mechano-sensitivity (13). Neurodynamic mobilization restores the neural tissue ability to withstand stress or tension via inducing reconstruction of normal physiological functions, reduction of pain, and improvement of function (14).

The slider neurodynamic mobilization technique produces sliding movement of the neural tissue in relation to its adjacent structures, which distributes tension and compression along the nervous system instead of one specific region. The tensioner neurodynamic mobilization technique produces tension in the neural tissue but without exceeding the tissue elastic capacity which increase viscoelastic properties of the nerve. It is obtained via bringing the nerve into an elongated position, end-range movement, holding this position for a short period, and then completely releasing this tension (15). Stretching exercises represent a good treatment to reduce pain and increase range of motion (ROM). It represents an essential component of physiotherapy programs for treatment of chronic LBP (16). Poor ergonomics and assuming faulty posture during activities of daily living led to restrictions of the spinal mobility, which induce disc herniation and LBP. The musculoskeletal restrictions impair normal muscle synergies which increase the energy needed to maintain stable posture (17). Ergonomic advices can greatly reduce painful symptoms and together with appropriate physiotherapy help patients to live and work pain free (18).

Neurodynamic mobilization is very effective in reducing symptoms and limitations in discogenic sciatica (19). It significantly reduced sciatic pain and restored sciatic nerve mobility (20, 21). The current work took a step in getting an evidence of the best treatment modalities in the management of sciatica and its related disabilities. Up to the authors knowledge, there is no previous study directly compared the slider technique, the tensioner technique, and stretching exercises for chronic discogenic sciatica. Therefore, the aim of the study is to determine which intervention is most effective in reducing pain, increasing ROM, and improving functional disability.

2. Materials And Methods

2.1. Study design and sample size calculation

This study was three armed randomized, single blinded (Only the therapist knows which technique or exercise was given to each patient without informing patients which group they were in), controlled clinical trial. It was conducted at the Kafrelsheikh University physical therapy faculty outpatient clinics from September 2020 to March 2021. The study was executed under the ethical guidelines of 1964 declaration of Helsinki and was registered in the clinical trial registry with clinical trial.gov ID: NCT04746690. The study was approved by the Ethical Committee for Human Research at the Faculty of Physical Therapy, Cairo University, Egypt (Reference number: P.T. REC/012/002874). Patients were invited to join the study and signed written consent form for their approval. To avoid type II error, a preliminary power analysis using G-power version 3.1.9.7 for windows (F-test, $\alpha = 0.05$, confidence interval = 95% and effect size = 0.25, groups = 3 and evaluation time = 2) determined total sample size of 36 patient (twelve in each group).

2.2. Inclusion criteria

Patients were eligible for participation in this study if their age ranged between 21–50 years, both genders, diagnosed by magnetic resonance imaging to confirm disc lesion, had radicular pain for more than 12 weeks up to 1 year with no acute episodes in the last 4 weeks, had a positive slump test with reproduction of neurological symptoms, and had functional disabilities in certain daily tasks as in lifting or walking.

2.3. Exclusion criteria

Patients were excluded if they had sciatica due to other pathologies (e.g. lumbar canal stenosis or piriformis syndrome), had any prior spinal surgery (e.g. unilateral hemilaminectomy or microdiscectomy), had a negative slump test, had progressive neurological symptoms (e.g. hyperirritable and unstable symptoms), history of vertebral fracture or trauma, had systemic disorders (e.g. diabetes mellitus), or were pregnant.

2.4. Patient's preparation and randomization

To reach the specific sample size, 47 patients were enrolled (to consider the drop-out from the time of randomization to the end of the treatment protocol) and assessed using the inclusion/exclusion criteria. Patients who are not eligible or did not adhere to the study assumptions or the ergonomic advice were excluded. The flow chart of the study is shown in figure (Fig. 1).

To avoid selection bias, the patients were randomly allocated by simple random method via choosing one of three wrapped cards representing the three treatment groups. Group (A) received the slider neurodynamic mobilization, while group (B) received the tensioner neurodynamic mobilization, and group (C) received stretching exercises of back extensors, hamstrings and gastrocnemius muscles. Furthermore, ergonomic advices were given to all groups.

All interventions, evaluation and recording of all measurements pre- and post-treatment were performed by the primary investigator (the same therapist). He has more than 5 years of experience in physical therapy and underwent formal training in clinical neurodynamic including techniques application from professors in faculty of physical therapy, Cairo University. All patients, eligible for the study by the inclusion criteria, were given explanation of the treatment protocol in a simple language and they had the willing and the ability to participate in the study. It was assumed that all patients were directed by the therapist to stop taking pain-relieving drugs or perform any stressful physical work that may interfere with the treatment effectiveness during participation in the current study. Furthermore, they all adhered to the precautionary measures against the pandemic Corona virus disease-2019 (Covid-19) during the sessions.

2.5. Clinical evaluation

The slump test:

The slump test resembles the straight leg raising (SLR) test performed in sitting position combined with spinal flexion that induces more neural tension (22). Patient is in sitting position on the edge of a plinth, asked to flex thoracic and lumbar spine first, then asked to flex his neck to get his chin on his chest. The examiner's hand is placed on the top of the patient's head and his elbow on the patient's thoracic spine maintaining this position. The patient is asked to actively extend his knee and dorsiflex his ankle until reproduction of his pain/symptoms or until end range is reached. Finally, as a structural differentiation maneuver, the examiner removed his hand from the head of the patient and asked him to look up; if the neural tissue is affected, the symptoms will decrease which indicate a positive slump test (23).

2.6. Assessment procedures

2.6.1. Measurement of pain intensity using the visual analogue scale (VAS):

The patient was asked to put a mark on a horizontal continuous 10 cm line that represents his pain intensity, ranging from zero, which indicates no pain, or discomfort to 10, which indicates the worst possible pain he could feel (24). It has good validity and reliability for pain intensity measurement (25).

2.6.2. Measurement of hip flexion ROM during passive SLR using the universal goniometer:

The patient was in supine position and the hip is flexed until symptoms was reproduced or until the limit of motion while keeping the knee extended and the ankle relaxed in plantar flexion. The patient's non-tested lower limb is fixed on the plinth using a strap for pelvic stabilization. The goniometer axis was over the greater trochanter of the femur and stationary arm was parallel to the mid axillary line and the movable arm was parallel to the longitudinal axis of the femur toward the lateral epicondyle (26).

2.6.3. Measurement of knee extension ROM during the slump position using the universal goniometer:

The patient was in the same position of slump test and his cervical spine was in the neutral position. A strap was fastened across his thighs to stabilize it and avoid substitutions. The patient was asked to flex his neck until his chin touch his chest, maintaining this position, then the examiner applied ankle dorsiflexion and passively extends the knee joint until the onset of reproduction of symptoms. The goniometer axis was over the lateral epicondyle of the femur, the stationary arm was between the lateral condyle of the knee and the greater trochanter, and the movable arm was between the lateral condyle of the knee and the lateral malleolus of the ankle. The ROM of knee flexion at this limit is measured relative to the operationally defined zero position (27).

2.6.4. Measurement of lumbar flexion ROM by Modified-Modified Schober Test (MMST):

The patient was standing with feet were shoulder width apart, a marker and measurement tape were used to measure the distance between two points; the first is the midpoint of the line connecting the posterior superior iliac spines, while the second point lies 15 cm above the first. The patient was asked to flex his trunk as much as he could. A second measure was taken to measure the distance between the same points. The difference between the two measures indicates the lumbar flexion ROM (26). MMST has high validity (28) and excellent reliability (29), for measurement of lumbar flexion ROM.

2.6.5. Functional disability assessment by Oswestry disability index (ODI):

ODI is a self-administered questionnaire, which includes 10 items; each contains six levels ranging between 0–5. The items include pain intensity, personal care, lifting objects, walking, sitting, standing, sleeping, sex life, social life, and travelling. A total score is calculated, divided by 50 and multiplied by 100. The score of the scale ranges between 0% indicating no disability to 100% indicating complete disability. Interpretation of ODI based on scores as following: from 0 to 20% indicates minimal disability; from 20 to 40% moderate disability; from 40 to 60%: severe disability; from 60 to 80% crippled and greater than 80%: the patient has excessive incapacity (30). Arabic version of ODI is simple to understand and has high validity and reliability for assessment of functional disability (31).

2.7. Treatment procedures

The treatment protocol in each group consisted of three sessions per week for two weeks.

2.7.1. The slider neurodynamic mobilization technique:

In the slump position, the patient was sitting at the edge of the plinth with the thighs parallel to each other and arms crossing behind the back. The examiner asked the patient to move actively and conversely from a position of neck and trunk flexion, knee flexion, and ankle plantar flexion, to a position of neck and trunk extension, knee extension, and ankle dorsiflexion (15).

2.7.2. The tensioner neurodynamic mobilization technique:

In the slump position, the patient was sitting at the edge of the plinth with the thighs parallel to each other and arms crossing behind the back. The examiner asked the patient to move actively and conversely from a position of neck and trunk extension, knee flexion, and ankle plantar flexion, to a position of neck and trunk flexion, knee extension, and ankle dorsiflexion (15).

Both techniques (slider and tensioner) were provided three sets in every session; the first: 10 repetitions, while the second: 15 repetitions, and the third: 20 repetitions. The repetitions were gradually increased to assure patients tolerance and to eliminate any adverse response during the techniques. The end position is hold for 5 seconds and the rest between sets is 5 minutes.

2.7.3. Stretching exercises:

A. Stretching of back extensor muscles:

The patient assumed cross sitting position and asked to place his hands behind his neck adducting his scapulae and extending his thoracic spine to lock the thoracic vertebrae. The examiner stabilized the patient's pelvis via pulling back on the anterior-superior iliac spines and asked the patient to lean the trunk anteriorly flexing only at the lumbar spine (32).

B. Stretching of the hamstrings muscle:

The patient assumed long sitting position and asked to lean forward as much as he could, and the examiner press down with his hands against the femur just above (not on) the patella to maintain knee extension (22).

C. Stretching of the gastrocnemius muscle:

The patient was standing on an inclined board with the patient's toes pointing upward and heels downward and asked to lean forward as much as he could (22).

Each muscle stretching was hold for 30 seconds, then a relaxation period of 30 seconds, three repetitions every session and one minute rest was given between stretching of each muscle.

2.7.4. Ergonomic advice:

Ergonomic advice was given to each patient to help him live, work and sleep comfortably, as the following:

- A. Maintain good posture and stand up erect without deviations.
- B. Avoid sitting or standing for long time and take regular breaks with standing or walking around during work. Furthermore, raise one foot on a footrest with switching your feet along work hours.
- C. Maintain proper sleeping posture to minimize stress on your back via sleeping on one side or on your back with bending the knees slightly over a pillow.
- D. Lift objects safely, make sure you lift anything from the squatting position and the weight is near to the body as much as you can.

- E. Avoid wearing high heels: greater than 1½ inches high may predispose you to pain or injury due to anterior shift of the body weight.
- F. Do swimming regularly to strengthen muscles (6).

The examiner provided written notes and pictures illustrating these advices to all patients.

2.8. Data collection and statistical analysis

The Demographic data and clinical characteristics of all patients (age, weight, height, body mass index (BMI), radicular pain duration, gender, and affected side) were presented, tabulated, and analyzed for normality using Shapiro–Wilk test. The statistical analysis was performed using SPSS, version 26 for windows (Armonk, NY: IBM Corp). Descriptive statistics (mean and standard deviation) of the demographic data of all patients in the three groups were presented. One-way analysis of variance (ANOVA) and chi-square tests were used for comparison of demographic data between the three groups. Paired t-test was used to compare between the pre- and post-treatment mean values of all variables in the three groups. One-way multivariate analysis of variance (MANOVA) test was used to compare all the dependent variables pre- and post-treatment between the three groups. Post hoc analysis was done for multiple comparisons using Tukey test. Level of significance for all tests was set at $p\text{-value} \leq 0.05$.

3. Results

Out of 47 participants screened, 36 participants were eligible to participate, and they were randomly assigned into three groups.

All data were normally distributed as assessed by Shapiro–Wilk test and histograms and revealed homogeneity of variance as assessed by Levene’s test with $p\text{-value} \geq 0.05$. No univariate or multivariate outliers in the present data as tested using Mahalanobis distance and no multicollinearity as assessed by correlation analysis.

There were no significant differences between the mean values of age ($p= 0.59$), weight ($p= 0.45$), height ($p= 0.85$), BMI ($p= 0.43$), and radicular pain duration ($p= 0.76$) for all groups as assessed by one-way ANOVA test, table (1). No significant difference were found between the three groups for gender ($p= 0.89$) and affected leg side ($p= 0.43$) as assessed by Chi-square test.

1. Pain intensity (VAS):

Paired t-test pre- and post-treatment mean comparison for each group revealed significant differences in the slider ($p= 0.0001^*$), tensioner ($p= 0.0001^*$), and stretching ($p= 0.0001^*$) groups as shown in table (2) and figure (2).

2. Hip flexion ROM:

Paired t-test pre- and post-treatment mean comparison for each group revealed significant differences in the slider ($p= 0.0001^*$), tensioner ($p= 0.0001^*$), and stretching ($p= 0.0001^*$) groups, as shown in table (3) and figure (3).

3. Knee extension ROM:

Paired t-test pre- and post-treatment mean comparison for each group revealed significant differences in the slider ($p= 0.0001^*$), tensioner ($p= 0.0001^*$), and stretching ($p= 0.0001^*$) groups, as shown in table (4) and figure (4).

4. Lumbar flexion ROM:

Paired t-test Pre- and post-treatment mean comparison for each group revealed significant differences in the slider ($p= 0.0001^*$), tensioner ($p= 0.0001^*$), and stretching ($p= 0.002^*$) groups, as shown in table (5) and figure (5).

5. Functional disability (ODI):

Paired t-test pre- and post-treatment mean comparison for each group revealed significant differences in the slider ($p= 0.0001^*$), tensioner ($p= 0.0001^*$), and stretching ($p= 0.0001^*$) groups, as shown in table (6) and figure (6).

One-way MANOVA for the pre-treatment means of all outcomes between the three groups revealed no significant differences between the slider, tensioner, and stretching groups for pain intensity (VAS) ($p= 0.6$), hip flexion ROM ($p= 0.61$), knee extension ROM ($p= 0.24$), lumbar flexion ROM ($p= 0.41$), and functional disability (ODI) ($p= 0.3$).

One-way MANOVA for the post-treatment means of all outcomes between the three groups revealed significant differences between the slider, tensioner, and stretching groups for pain intensity (VAS) ($p= 0.002^*$), hip flexion ROM ($p= 0.0001^*$), knee extension ROM ($p= 0.0001^*$), lumbar flexion ROM ($p= 0.0001^*$), and functional disability (ODI) ($p= 0.0001^*$).

Post hoc tests (Tukey) for multiple comparisons between post-treatment means of all outcomes between the three groups (table 7) revealed significant differences in the slider group as compared to the stretching group in all outcomes. Furthermore, there were significant differences in the tensioner group as compared to the stretching group in all outcomes. Moreover, there were significant differences in the slider group as compared to the tensioner group in ROM of hip flexion, knee extension, and lumbar flexion.

4. Discussion

The current work compared the effectiveness of slider, tensioner neurodynamic mobilization techniques and stretching exercises on pain, function, and ROM of patients with chronic discogenic sciatica. The

main finding of this clinical trial is that slider and tensioner neurodynamic mobilization techniques were more effective compared to stretching exercises in reducing pain, increasing hip flexion, knee extension and lumbar flexion ROM, and improving functional disability. Furthermore, the slider technique had a greater effect as compared to the tensioner technique regarding ROM and succeeded to improve mobility of hip flexion, knee extension, and lumbar flexion.

This study results supported the effectiveness of neurodynamic mobilization in the management of discogenic sciatica concerning pain alleviation and sciatic nerve mobility restoration. After nerve root compression, the nerve induces oedema and hypoxia which compromise microcirculation. Neurodynamic mobilization techniques associated with short, sustained movements was effective to reduce oedema and alleviate hypoxia which further reduced the associated symptoms and dysfunctions (15).

Slider techniques are very effective in the treatment of neural disorders in which the pain is the chief complain. It removes the inflammatory exudates and facilitates tissue oxygenation which help to restore the normal physiological status of the nerves. On the other hand, tensioner techniques are used to induce viscoelastic, movement related and physiological reactions in the neural tissues. Tension is applied to the neural tissues via increasing the distance between both ends of the nerve (15).

Slider techniques mobilize the nerve over their distal root while relieve stress over their proximal attachment and vice versa. On the other hand, tensioner techniques further mobilize the nerve over their proximal and distal attachment at the same time. Thus, slider techniques induce less nerve strain than tensioner techniques (33).

The findings of this study are in line with the results of the in vivo trial using ultrasound imaging conducted by Ellis et al., (34) who measured longitudinal sciatic nerve movement during the slider and tensioner neurodynamic mobilization techniques. They found that both techniques induced improvement in sciatic nerve mobility and excursion with a more significant effect for the slider technique.

Moksha et al., (35) compared the effectiveness of the slider and tensioner neurodynamic mobilization techniques combined with home exercise program on 60 patients with Non-specific LBP associated with radicular lower limb symptoms. He suggested that both techniques have better positive effects on reducing pain intensity, increasing hip flexion ROM, and improving functional disability with more significant effect for the slider neurodynamic mobilization technique in all outcomes measured. These results contrast with our findings regarding the pain intensity and functional disability, which may be attributed to differences in sample size being double of the sample used in current work.

The slider technique had immediate effect on improving knee extension ROM in patients with sciatica (36). It improved knee extension and hip flexion ROM more than the tensioner technique group or the control joint mobilization group in patients with short hamstring syndrome in a recent randomized controlled trial (RCT) with a large sample size of 105 participants (37).

Herrington (38), applied both slider and tensioner neurodynamic mobilization techniques on young healthy female subjects and concluded that both techniques increased ROM of knee extension with no statistically significant difference between them. The insignificant difference may be attributed to the participants age and activity level being normal subjects. Another comparison for the healthy subjects with hamstring tightness was applied in the three-armed RCT conducted by Sharma et al., (39) who combined the slider and tensioner neurodynamic mobilization techniques with static hamstrings stretching in two separate experimental groups, while the third control group received only static hamstrings stretching. He found that both techniques have better effects than static stretching in improving knee extension ROM but with no statistically significant difference between them.

The slider technique, when applied in combination with conventional physiotherapy (CP), was more effective in reducing pain intensity, improving hip flexion ROM, and improving functional capabilities more than the CP alone for patients with chronic discogenic sciatica (40). Furthermore, pain intensity, hip flexion ROM, functional disability, and lumbar flexion ROM measured by MMST were improved when slider technique combined with CP compared to CP alone in patients with sub-acute discogenic sciatica (41).

The current work took a step in getting an evidence of the best treatment modalities in the management of sciatica and its related disabilities, but, as all experimental studies it has some limitations. Pain intensity measurements may be affected by the patient's psychological conditions during assessment because it is considered a subjective measure indicated by the patient's preference. Furthermore, variations in individual's commitment to the study assumptions and ergonomic advice may influence the results. The patient's commitment in this critical time while the pandemic Covid-19 invades the whole world was affected, which made some patients involuntarily not capable to complete the treatment protocol.

It is recommended that further studies should be conducted with large sample size and long-term follow up. Furthermore, more objective tools e.g., electro goniometer or computer assisted video motion analysis system to measure ROM may be beneficial. Ultrasonography may be used to correlate between nerve excursion and symptomatic improvement secondary to neurodynamic mobilization techniques.

Clinical implications

- Slider and tensioner neurodynamic mobilization techniques are more effective than stretching in terms of reducing pain, increasing ROM of hip flexion, knee extension, and lumbar flexion, and improving functional capabilities for patients with chronic discogenic sciatica.
- The slider has a greater effect than the tensioner in enhancing ROM.

5. Conclusion

The findings of the current study demonstrate that the slider and tensioner neurodynamic mobilization techniques should be included in the physiotherapy programs in treatment of patients with chronic

discogenic sciatica noting that the slider technique has better effects and more comfortable for patients.

Declarations

Ethics approval and consent to participate:

The study was executed under the ethical guidelines of 1964 declaration of Helsinki and was registered in the clinical trial registry with clinical trial.gov ID: NCT04746690. The study was approved by the Ethical Committee for Human Research at the Faculty of Physical Therapy, Cairo University, Egypt (Reference number: P.T. REC/012/002874). Patients were invited to join the study and signed written consent form for their approval

Consent for publication

The authors give their consent for the publication of identifiable details, which can include photograph(s) and/or videos and/or case history and/or details within the text ("Material") to be published in the above Journal and Article.

Availability of data and materials

The data that support the findings of this study are available from the corresponding author, [Mona M Ibrahim], upon reasonable request.

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Authors' contributions

1. Research concept and design Haytham Ibrahim Morsi and Bassem Galal Eldein El Nahass
2. Collection and/or assembly of data: Haytham Ibrahim Morsi
3. Data analysis and interpretation: Haytham Ibrahim Morsi
4. preparations of figures and tables: Haytham Ibrahim Morsi
5. Writing the main manuscript of the article Haytham Ibrahim Morsi and Mona Mohamed Ibrahim
6. Critical revision of the article: Mona Mohamed Ibrahim and Bassem Galal Eldein El Nahass

7. Final approval of article: Mona Mohamed Ibrahim and Bassem Galal Eldein El Nahass

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Tables

Table 1: Descriptive statistics and one-way ANOVA test for the mean values of age, weight, height, BMI, and radicular pain duration in all groups

Items	Mean ± SD			F-value	P-value	Sig.
	Slider group	Tensioner group	Stretching group			
Age (years)	35.83 ± 7.18	32.92 ± 7.33	34.92 ± 6.46	0.55	0.59	NS
Weight (kg)	78.25 ± 6.58	78.92 ± 5.92	81.17 ± 4.88	0.82	0.45	NS
Height (cm)	170.83 ± 7.33	172.5 ± 6.92	171.25 ± 7.79	0.17	0.85	NS
BMI (Kg/m ²)	26.83 ± 3.71	26.42 ± 1.93	27.92 ± 2.75	0.86	0.43	NS
Radicular pain duration (months)	5.92 ± 2.47	6.17 ± 2.69	5.42 ± 2.39	0.23	0.76	NS

BMI= Body mass index, SD= Standard deviation, F-value= F-statistic, P-value= probability, Sig.= Significance, NS= non-significant.

Table 2: Paired t-test comparison for pre- and post-treatment mean values of pain intensity (VAS) for all groups.

Items	Pain intensity (VAS)		Mean difference	% of improvement	T-value	P-value	Sig.
	Mean ± SD						
	Pre	Post					
Slider group	7.42 ± 1.17	2.75 ± 1.36	4.67	62.94%	18.21	0.0001*	S
Tensioner group	6.83 ± 1.53	3.08 ± 1.24	3.75	54.9%	10.69	0.0001*	S
Stretching group	7.08 ± 1.24	4.83 ± 1.64	2.25	31.78%	7.39	0.0001*	S

VAS= Visual analogue scale, SD = Standard deviation, % = Percentage, T-value = t-statistic, P-value = Probability, Sig. = Significance, * = Statistically significant, S = Significant.

Table 3: Paired t-test comparison for pre- and post-treatment mean values of hip flexion ROM for all groups.

Items	Hip flexion ROM		Mean difference	% of improvement	T-value	P-value	Sig.
	Mean \pm SD						
	Pre	Post					
Slider group	52.58 \pm 5.35	82.83 \pm 4.13	-30.25	57.53%	-17.24	0.0001*	S
Tensioner group	52.08 \pm 4.21	75.67 \pm 4.96	-23.58	45.28%	-23.5	0.0001*	S
Stretching group	54.08 \pm 5.35	69.33 \pm 6.04	-15.25	28.2%	-14.2	0.0001*	S

ROM= Range of motion, SD = Standard deviation, % = Percentage, T-value = t-statistic, P-value = Probability, Sig. = Significance, * = Statistically significant, S = Significant.

Table 4: Paired t-test comparison for pre- and post-treatment mean values of knee extension ROM for all groups.

Items	Knee extension ROM		Mean difference	% of improvement	T-value	P-value	Sig.
	Mean \pm SD						
	Pre	Post					
Slider group	31.92 \pm 3.37	14.08 \pm 3.32	17.83	55.86%	37.62	0.0001*	S
Tensioner group	33.83 \pm 4.15	19.08 \pm 3.61	14.75	43.6%	16.93	0.0001*	S
Stretching group	31.08 \pm 4.32	24.25 \pm 3.84	6.83	21.98%	15.5	0.0001*	S

ROM= Range of motion, SD = Standard deviation, % = Percentage, T-value = t-statistic, P-value = Probability, Sig. = Significance, * = Statistically significant, S = Significant.

Table 5: Paired t-test comparison for pre- and post-treatment mean values of lumbar flexion ROM for all groups.

Items	Lumbar flexion ROM		Mean difference	% of improvement	T-value	P-value	Sig.
	Mean \pm SD						
	Pre	Post					
Slider group	4.75 \pm 1.14	7.25 \pm 0.97	-2.5	52.63%	-8.66	0.0001*	S
Tensioner group	4.67 \pm 1.07	6.17 \pm 0.94	-1.5	32.12%	-6.51	0.0001*	S
Stretching group	4.17 \pm 1.19	4.92 \pm 0.98	-0.75	17.99%	-4.18	0.002*	S

ROM= Range of motion, SD = Standard deviation, % = Percentage, T-value = t-statistic, P-value = Probability, Sig. = Significance, * = Statistically significant, S = Significant.

Table 6: Paired t-test comparison for pre- and post-treatment mean values of functional disability (ODI) for all groups.

Items	Functional disability (ODI)		Mean difference	% of improvement	T-value	P-value	Sig.
	Mean \pm SD						
	Pre	Post					
Slider group	44.42 \pm 4.79	18 \pm 3.52	26.42	59.48%	30.21	0.0001*	S
Tensioner group	42.08 \pm 3.37	21.08 \pm 2.68	21	49.9%	30.64	0.0001*	S
Stretching group	43.83 \pm 2.92	28.08 \pm 4.94	15.75	35.93%	19.05	0.0001*	S

ODI= Oswestry disability index, SD = Standard deviation, % = Percentage, T-value = t-statistic, P-value = Probability, Sig. = Significance, * = Statistically significant, S = Significant.

Table 7: Multiple comparisons: post hoc tests (Tukey).

Groups	Mean difference	P-value	Sig.
Pain intensity (VAS)			
Slider - Tensioner groups	-0.33	0.84	NS
Slider - Stretching groups	-2.08	0.003*	S
Tensioner – Stretching groups	-1.75	0.01*	S
Hip flexion ROM			
Slider - Tensioner groups	7.17	0.004*	S
Slider - Stretching groups	13.5	0.0001*	S
Tensioner – Stretching groups	6.33	0.01*	S
Knee extension ROM			
Slider - Tensioner groups	-5	0.005*	S
Slider - Stretching groups	-10.17	0.0001*	S
Tensioner – Stretching groups	-5.17	0.004*	S
Lumbar flexion ROM			
Slider - Tensioner groups	1.08	0.03*	S
Slider - Stretching groups	2.33	0.0001*	S
Tensioner – Stretching groups	1.25	0.009*	S
Functional disability (ODI)			
Slider - Tensioner groups	-3.08	0.14	NS
Slider - Stretching groups	-10.08	0.0001*	S
Tensioner – Stretching groups	-7	0.0001*	S

VAS= Visual analogue scale, ROM= Range of motion, ODI= Oswestry disability index, P-value= probability, Sig.= Significance, *= Statistically significant, NS= Non-significant, S= significant.

Figures

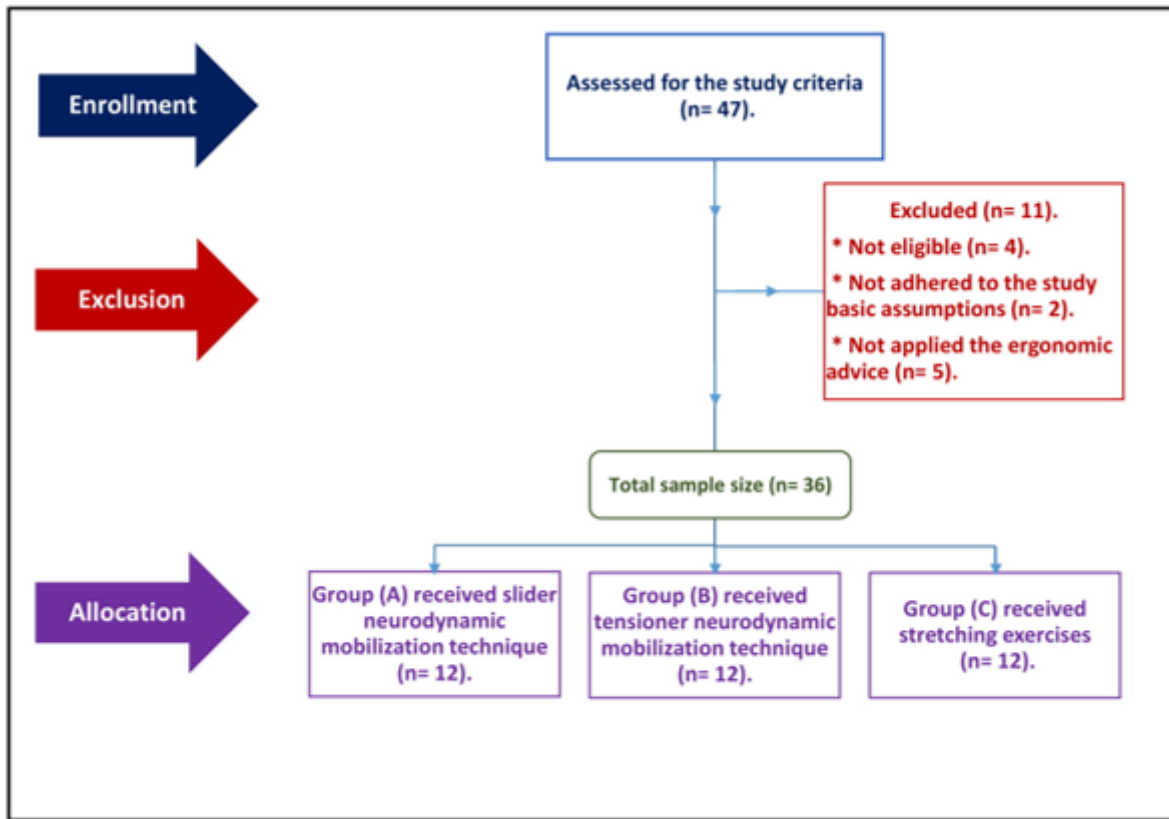
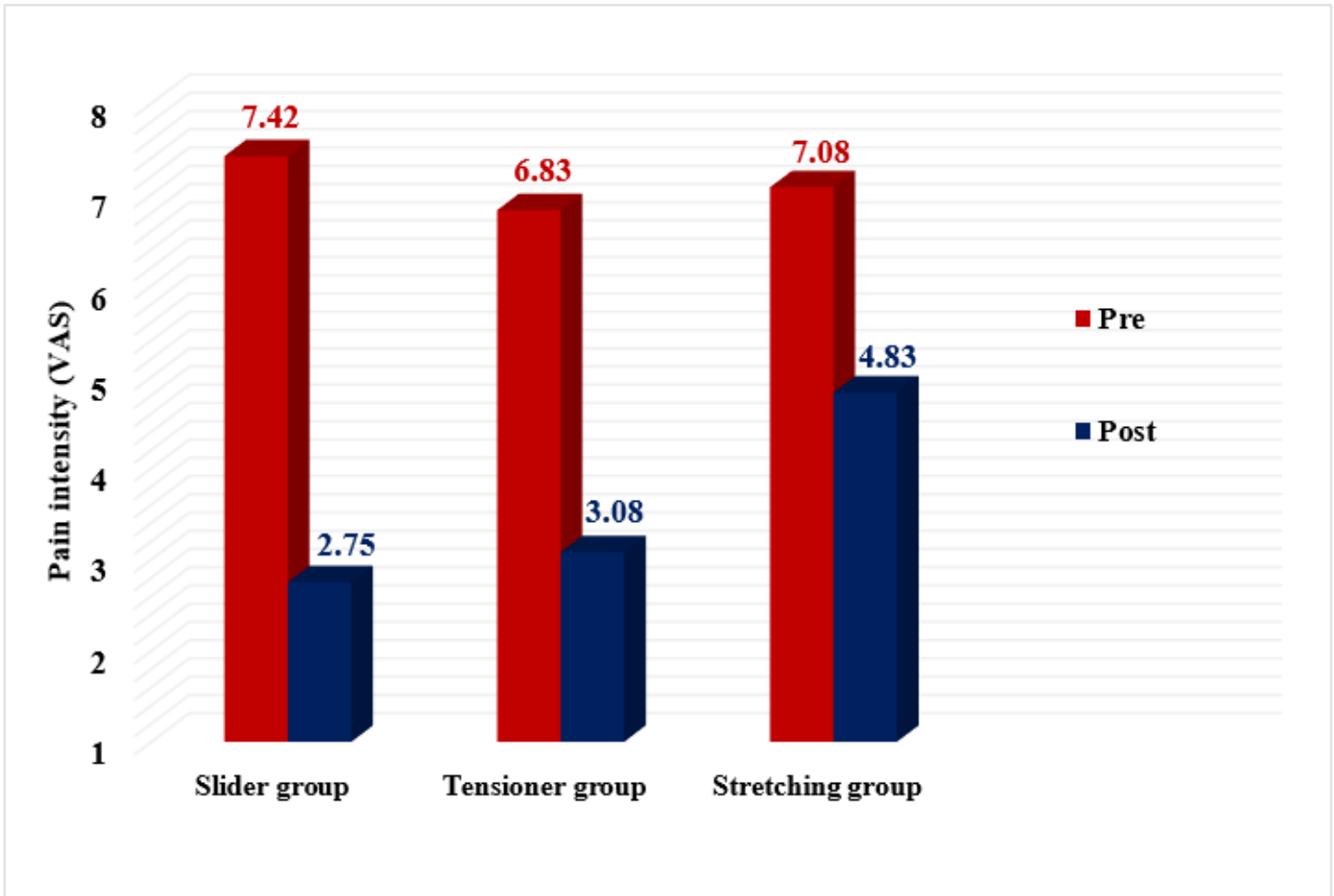


Figure 1

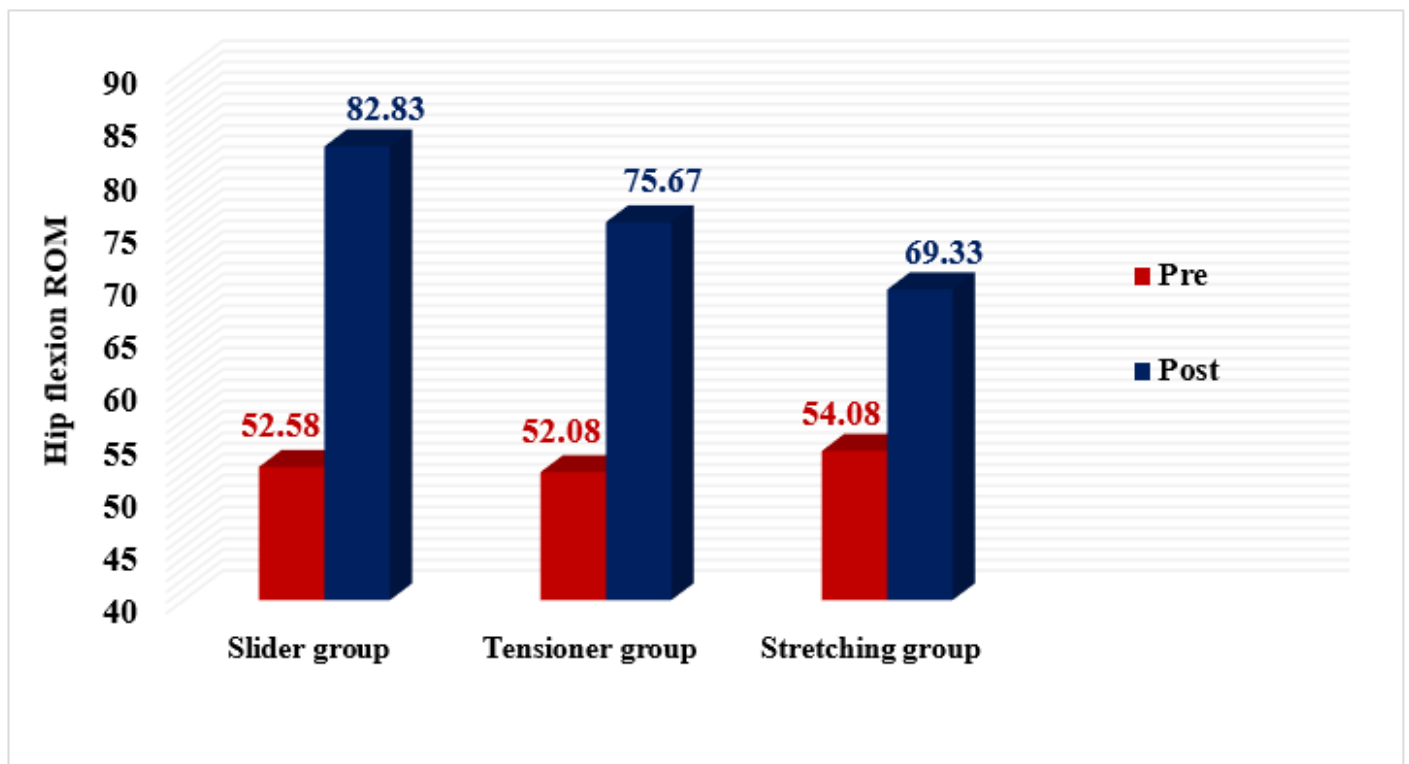
The study flow chart.



VAS= Visual analogue scale.

Figure 2

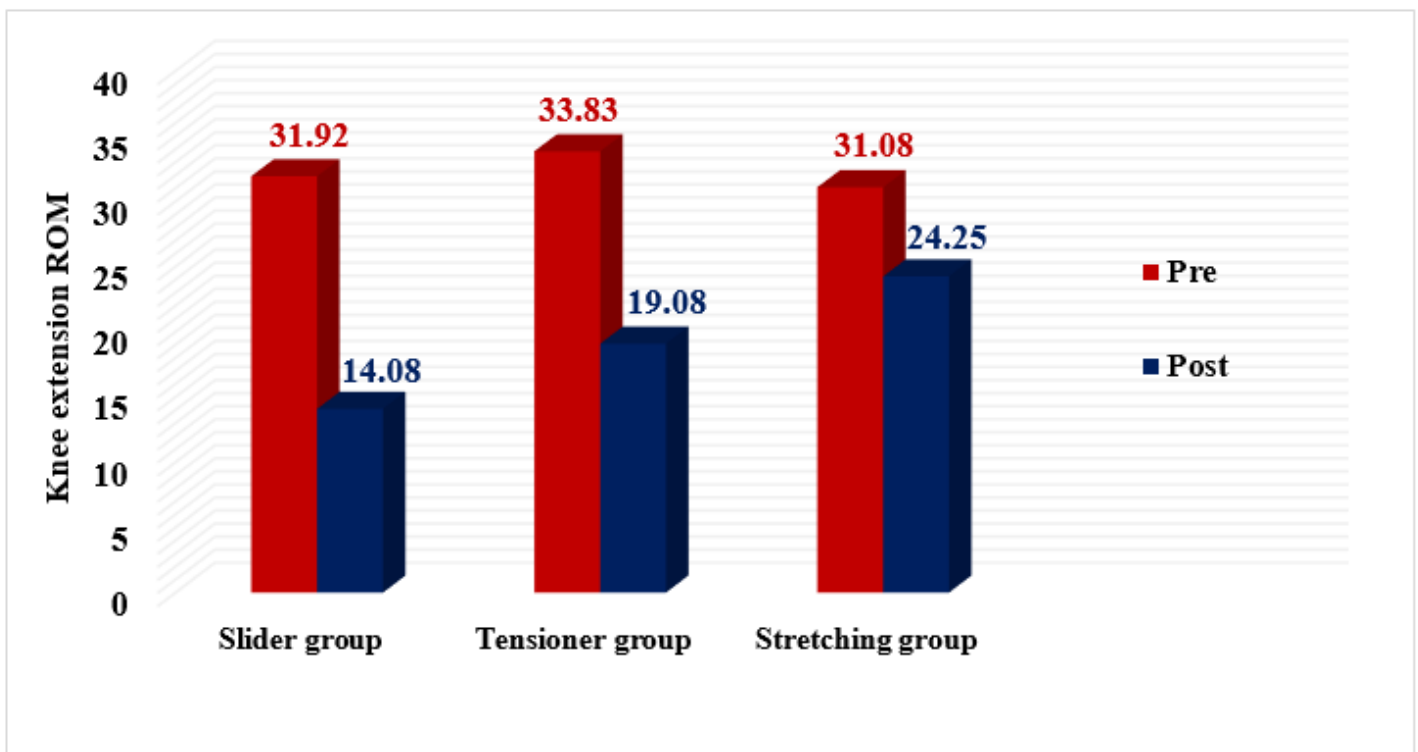
Pre- and post-treatment mean values of pain intensity (VAS) for all groups.



ROM= Range of motion.

Figure 3

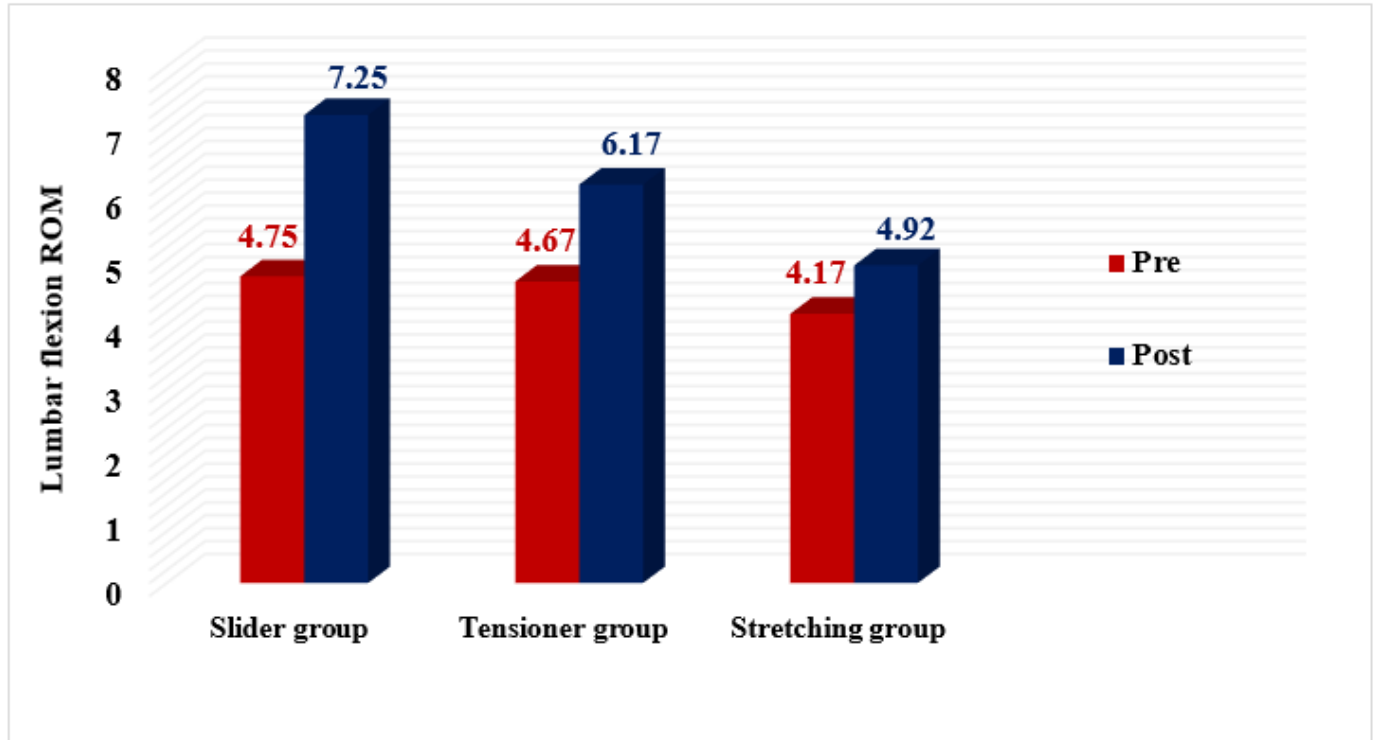
Pre- and post-treatment mean values of hip flexion ROM for all groups.



ROM= Range of motion.

Figure 4

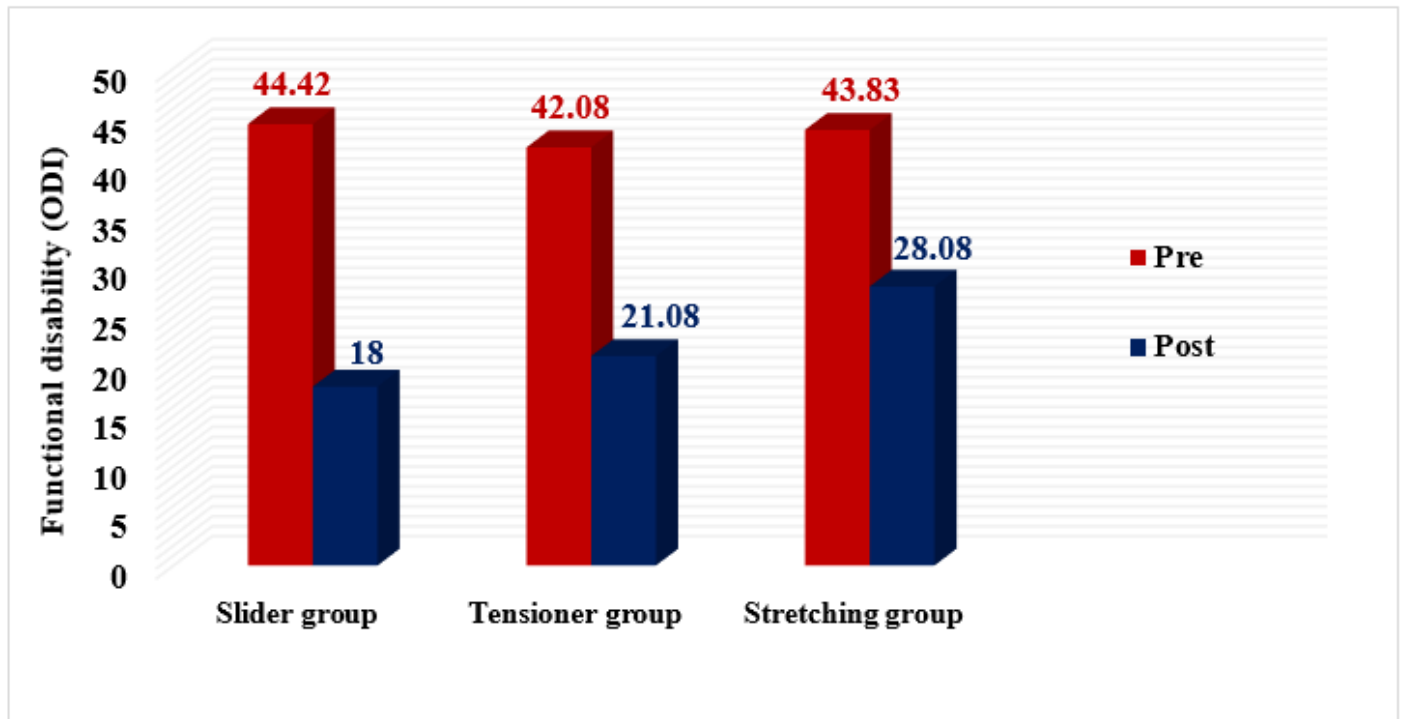
Pre- and post-treatment mean values of knee extension ROM for groups.



ROM= Range of motion

Figure 5

Pre- and post-treatment mean values of lumbar flexion ROM for all groups.



ODI= Oswestry disability index.

Figure 6

Pre- and post-treatment mean values of functional disability (ODI) for all groups.