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Original Research Article

Efficacy of Hip Abductor and Extensor Strengthening on Pain, Strength and Lower Extremity Function in Piriformis Syndrome: A Randomized Clinical Trial

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ABSTRACT

Background and Purpose: Piriformis syndrome is a collection of symptoms and signs of pain from piriformis muscle and is characterized by pain in buttock with variable involvement of sciatic nerve. The benefits of neural mobilization and piriformis stretching is widely described earlier but, the effect of hip abductor and extensor strengthening is not well described

Methods: 33 subjects with piriformis syndrome were randomly assigned into two groups. Among those 3 subjects (Group A- 1, Group B- 2) were dropped out due to personal reason. Subjects in group A (n=15) received 10 sessions of hip abductor and extensor strengthening along with neural mobilization & piriformis stretching whereas, group B (n=15) received 10 sessions of only neural mobilization and piriformis stretching for five sessions per week, in two weeks.

Outcome Measures: Pain intensity was measured by NPRS, isometric strength of hip abductor and extensor strength was measured by HHD and functional status was measured by LEFS.

Results: The results of this study showed that there is statistically significant improvement in both the groups for pain intensity and functional status. But, hip abductor and extensor strength showed statistically significant improvement only in Group A ($p<0.05$). In between group analysis, results showed statistically significant ($p<0.05$) changes in terms of hip abductor strength and LEFS but, differences of NPRS and hip extensor strength were statistically insignificant ($p>0.05$).

Conclusion: The study demonstrated that hip abductor and extensor strengthening have an added efficacy in improving hip abductor strength and functional status when combined with neural mobilisation and piriformis stretching exercises.

Key Words: Piriformis syndrome, Neural mobilization, Piriformis stretching.

INTRODUCTION

Piriformis syndrome is a neuromuscular disorder that occurs when the sciatic nerve is compressed or irritated by the piriformis muscle causing pain, tingling and numbness in the buttocks and along the sciatic nerve. Pain in the buttock that radiates down the leg is commonly called sciatica. One possible cause of sciatica is piriformis syndrome. The nerve splits through the piriformis muscle in about 20% of the population. [1] This syndrome occurs most frequently among populations in 4th and 5th decade of life and affects individuals regardless of type of occupations and level of activity. Prevalence of piriformis syndrome among chronic low back pain patients varies widely, between 5% and 36%. [2]

Symptoms associated with piriformis syndrome typically consist of buttock pain that radiates into the hip, posterior aspect of the thigh and the proximal portion of the lower leg that aggravates with sitting or squatting, but persons with piriformis syndrome may experience difficulty with walking or other functional activities. [3, 4]

When the piriformis becomes tight it can put pressure on the sciatic nerve causing irritation and sending pain down the back of the leg (sciatica). [5] Prevalence of sciatic symptoms is 5.1% for men and 3.7% for women aged 30 years or over.

Delay in diagnosing piriformis syndrome may lead to pathologic conditions of the sciatic nerve, chronic somatic dysfunction, and compensatory changes resulting in pain, paresthesia, hyperesthesia, and muscle weakness. The challenge for physicians is to recognize symptoms and signs that are unique to piriformis syndrome, enabling appropriate treatment in a timely manner.

A shortened piriformis can produce compression of sciatic nerve and a muscle held in a prolonged shortened position is liable to undergo weakness. Muscle shortening also increases wear and tear producing stretch effect on its tendon and leading to weakness, inflammatory and degenerative changes. An alternate theory suggests that, continuous loading of the piriformis muscle through over-lengthening and eccentric demand may result in weakness in hip musculatures.

Barton and Halin (1991) [6] in their study concluded that hip abductors strengthening exercise is needed in treatment of piriformis syndrome. [13] Therefore, a treatment program addressing hip strengthening to control the femur in the frontal plane during functional activities might play a role in the treatment of subjects with piriformis syndrome. Interestingly, many authors have recognized hip abductor weakness as an associated finding with piriformis syndrome. Yet only two of these reports included hip abduction strengthening as part of the treatment program [6,7] with one of them noted that hip abduction exercises "seemed to hasten recovery."

The most commonly reported physical therapy interventions include soft tissue mobilization, piriformis stretching, hot packs or cold spray and various lumbar spine treatments. [7] Neural mobilization has been demonstrated to produce mechanical effects in terms of nerve strain and excursion and has been one of the theoretically established modes of therapy for piriformis syndrome. [7] In neural mobilization sliding techniques involve combinations of movements that result in elongation of the nerve bed at one joint, while reducing the length of the nerve bed at an adjacent joint. It has been theorized to play a role in the dispersion of inflammatory products and limiting fibroblastic activity.

Tensioning techniques have been suggested to play a role in reducing intra-neural swelling and circulatory stasis by altering intra-neural pressure associated with these techniques. It has been demonstrated that these techniques exert different biomechanical effects on the nervous system. Sliding techniques are less aggressive in nature compared to tensioning techniques, which involve increasing the distance between each end of the nerve bed via elongation. [7]

Overloading of the piriformis muscle occurs due to the weakness of hip abductor & extensor muscle group, leading to shortening of piriformis muscle, ultimately compression of the sciatic nerve occurs. So, Strengthening of those muscles is needed to reduce strain on the piriformis muscle.

There is few literature evidences available which can show the efficacy of hip abductor & extensor strengthening on piriformis syndrome. So, purpose of the present study is to find out the effectiveness of hip abductor & extensor strengthening on piriformis syndrome.

MATERIALS & METHODS

Subjects: This Pre-test - post-test group study evaluated the efficacy of hip abductor

and extensor strengthening on pain, strength and lower extremity function in the management of piriformis syndrome patients came to the NILD, (Divyangjan), Kolkata, India between March, 2017 to February, 2018. Scientific and Ethical approval was taken from Institute Ethical Committee (IEC) on 24th February, 2017. Inclusion criteria were both male and female patients with piriformis syndrome from 30 to 50 years of age, patients with positive FAIR & Lasegue test, patients with grade 1 to 3 tenderness at the intersection of the piriformis muscle and the sciatic nerve, NPRS ranging from 3-9.The subjects were excluded if they had any disc pathology and facet joint pathology, congenital or acquired abnormality in the spinal column, having history of spinal trauma, joint dysfunction or congenital defects, spinal and lower limb deformity, pre-diagnosed musculo-skeletal abnormality in lumbar spine, hip and sacroiliac joint, pain due to any systemic inflammatory disease, rheumatologic conditions, pregnancy, malignancy, neurological condition, neurological conditions like, CVA, Parkinson's disease, non-cooperative & subjects with psychological impairment.

Procedure:

Total 57 Subjects diagnosed and referred with piriformis syndrome from the Assessment clinic of NILD to Physiotherapy department were approached with the proposal of the study. They were screened according to the inclusion and exclusion criteria. Among those, 24 subjects were excluded and remaining (n=33) subjects fulfilling the inclusion criteria were included. Then, 33 subjects were allocated into 2 groups, Group-A, n = 16 (Hip abductor & extensor strengthening and Sciatic nerve mobilization with piriformis stretching) & Group-B n = 17 (Sciatic nerve mobilization and piriformis stretching) by simple random sampling. For each subjects demographic data were collected before intervention. The data for pain intensity, muscle strength (hip extensor & abductor) and score on lower extremity functional scale were taken pre intervention and at the end of 10^{th} sessions of treatment. Medications (rescue drugs) as prescribed from the assessment clinic were continued in both the groups. Total 3 subjects were dropped out from the study (due to personal issue), 1 subject from Group A and 2 subjects from Group B. Post-intervention data were collected from 30 subjects, 15 subjects in each group. Study procedure is described in the consort flow diagram (Fig.1).

OUTCOME MEASURES

The measurement of pain intensity was done by using numeric pain rating scale. It is reliable and valid. [8] Subjects were explained about the scale and instructed to "indicate the intensity of current, best and worst pain" on a scale of zero (no pain) to ten (worst pain).The measurements were taken at pre-intervention & post-intervention after the end of 2 weeks of intervention.

The isometric muscle strength was measured for the involved hip abductor and extensor muscles by using Jamar hydraulic hand-held dynamometer (JHHD). For hip abductor strength testing, subjects were on side lying position in the couch, with the non-tested limb in flexion at hip & knee for the stabilization of pelvis/trunk. The test limb was kept in zero degree hip abduction and zero degree of hip and knee flexion. The device was placed over the lateral femoral condyle.

For hip extensors strength testing subject was in prone lying on the couch with knee flexed zero degree. [9] The device was placed against the distal end of posterior thigh. The subjects were asked to perform a maximal voluntary isometric contraction (MVIC) against the dynamometer, which was used to measure the applied force in kg. [10]

The individual test was administered three times to reduce a possible learning effect; the averages of three consecutive measurements were taken as the best value. 30 second rest period was given between the trials. [10]

Lower extremity functional status was assessed by Lower extremity Functional Scale with regards to buttock and posterior thigh symptoms. This is a self-assessment functional tool which is valid and reliable. Subjects were explained about all the items of LEFS and requested to tick on the questionnaire on the day of evaluation & again at the end of the treatment session (10^{th} day). The differences between these two data were studied to evaluate the pre & post-intervention condition of the subjects. [11]

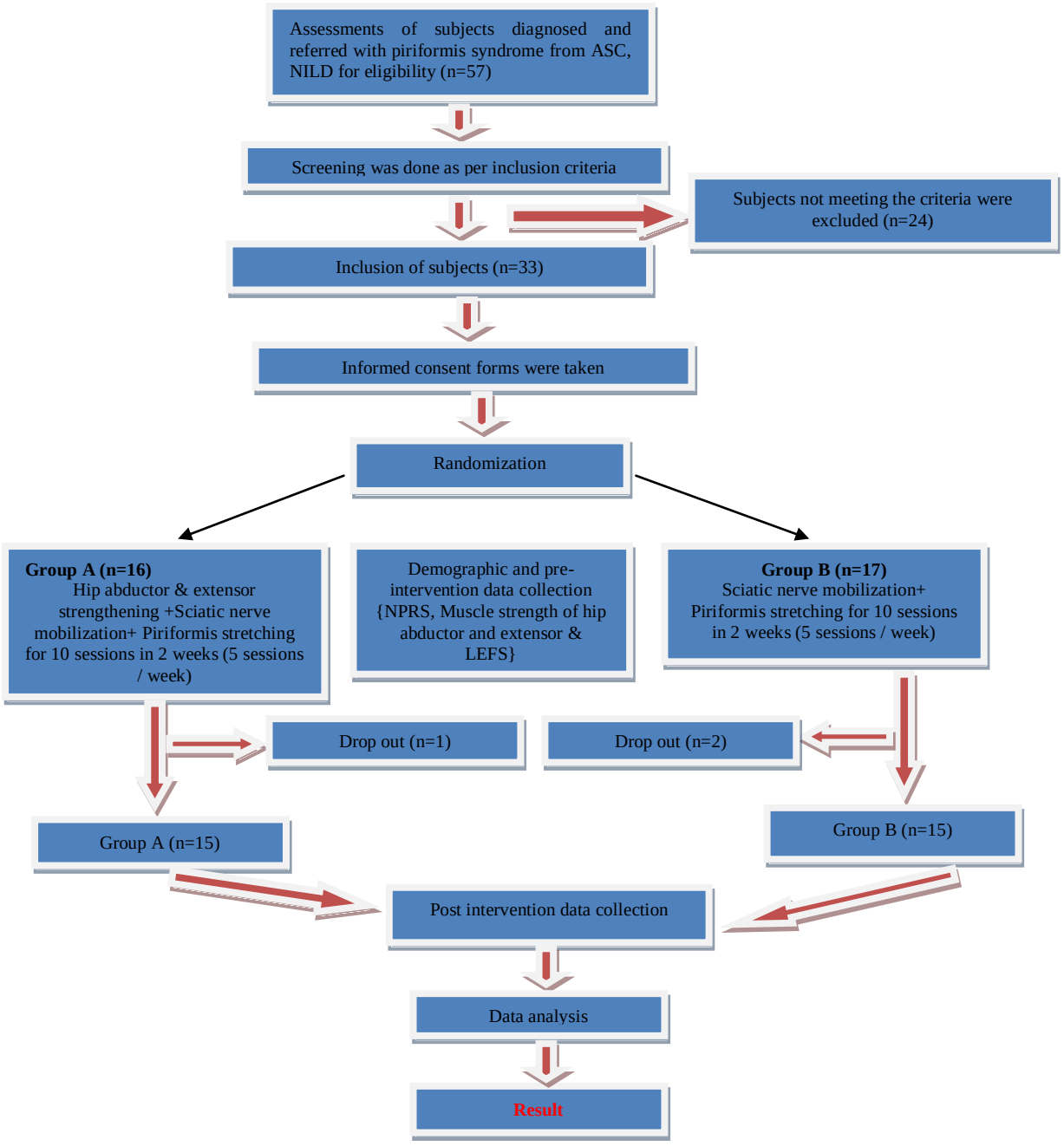


Fig. 1 Consort flow diagram

INTERVENTIONS

Group A: All the patients of this group were treated by hip abductor & extensor muscle strengthening along with sciatic nerve mobilization & piriformis stretching. Three sets of hip abductor & extensor muscle strengthening exercises with 10 sec

hold for 10 repetitions were done 5 days per week, for 2 weeks. [12, 13]

HIP ABDUCTOR STRENTHENING:

Subject's position was in side- lying with the affected side upward. Lower leg flexed at hip & knee. Pelvis was stabilized by therapist and upper leg kept out of couch at the level of ankle. One end of the elastic band was tied to the distal part of the affected leg while the other end tied around the leg of that couch, keeping the elastic band perpendicular to the floor. Subjects were instructed to lift the upper leg towards the ceiling against the force of the resistance band. [14]

HIP EXTENSOR STRENGTHENING:

Subject was in prone lying position keeping both the ankle out of the couch. Pelvis was stabilized by the therapist beside the couch. One end was tied around the distal leg and other end around the leg of the couch. Subjects were instructed to lift the leg towards the ceiling keeping the elastic band perpendicular to the floor. [14]

SCIATIC NERVE MOBILIZATION (Tensioning Technique)

Sciatic nerve mobilization was given for 12-15 sessions including 30 sec hold and 1 min rest. The subjects were in supine lying position and straight leg raise was done for inducing longitudinal tension as the sciatic nerve runs posterior to hip and knee joints while maintaining extension at the knee. In order to induce dural motion through the sciatic nerve; the leg was raised at least past 35 degrees in order to take up slack in the nerve. To introduce additional traction (i.e., sensitization) into the proximal aspect of the sciatic nerve, hip adduction was added to the straight leg raise. The whole treatment was continued for 10 sessions in 2 weeks. [7]

PIRIFORMIS STRETCHING

In supine lying position subject's tested leg was placed into flexion at the hip and knee so that the foot rests on the table lateral to the contra-lateral knee (the tested leg is crossed over the straight non-tested leg).The non-tested side pelvis was stabilized during the test and the knee of the tested side was pushed into adduction, to place a stretch on piriformis. Holding time was 20 seconds, with 5 seconds rest period and repeated for 5 times. [15]

Group B: All the subjects of this group were treated by sciatic nerve mobilization & piriformis stretching exercise as described above with similar dosage.

Statistical Analysis

R programme software version 3.2.5 was used for analysis of the data. Baseline characteristics of the data between the two groups were measured using "Independent t test". Paired sample t test were used to analyze the intra group variables for NPRS, hip abductor & extensor strength and lower extremity functional scale (LEFS). Independent t test were used to analyze the inter group variables for NPRS, hip abductor & extensor strength and LEFS using mean difference. The tests were applied at 95% confidence interval on α value set at 0.05. The results were taken to be significant if P-value <0.05.

RESULTS

In this study total 30subjects (24 females and 6 males) were evaluated with piriformis syndrome and were randomly divided into two groups (Group-A & Group-B). Mean age of subjects in Group-A was 43.26±6.34 and Group-B was 40.26±5.59.

Analysis of demographic details (age and gender) revealed that there was statistically insignificant difference between Group-A & Group-B at baseline (p=0.18). This shows that both the groups were homogenous at base line. (Table-1)

Table-1: Demographic Details

	Group-A (n=15)	Group-B (n=15)	t-value	p-value
AGE (Mean, SD)	43.26±6.34	40.26±5.59	1.37	0.18
MALE	03	03		
FEMALE	12	12		

Pain intensity:

Every subject after inclusion was assessed for intensity of pain by using NPRS. Subjects were instructed to "Indicate the intensity of current, best and worst pain on a scale of zero (no pain) to ten (worst pain)". This was measured at baseline (pre-

intervention) & at 10^{th} session (post-intervention).

Intra group comparison revealed that there was reduction of pain intensity in both the groups. Pain intensity decreased from 7.2±0.77 to 3.66±1.75 ($p<0.05$) in Group-A and from 7.13±1.06 to 3.8±1.14 ($p<0.05$) in Group-B. This reduction was statistically significant in both the groups (Table- 2).

Table-2: Intra group comparison of Pain Intensity of Group A& Group B

	Pre	Post	t-value	p-value	Significance
Group-A (n=15)	7.2±0.77	3.66±1.75	6.985	0.00	Significant
Group-B (n=15)	7.13±1.06	3.8±1.14	9.239	0.00	Significant

HIP ABDUCTOR STRENGTH:

Intra group analysis of hip abductor strength showed that hip abductor strength was increased in Group-A from **8.68±0.79** to **9.86±1.71** ($p<0.05$) and minimally decreased in Group-B from **9.28±1.59** to **9.26±1.62** ($p>0.05$). The change in Group-A is statistically significant whereas in Group-B it is insignificant (Table-3).

Table-3: Intra group analysis of hip abductor strength of Group A& Group B

	Pre (in Kg)	Post (in Kg)	t-value	p-value	Significance
Group-A (n=15)	8.68±0.79	9.86±1.71	-3.56	0.00	Significant
Group-B (n=15)	9.28±1.59	9.26±1.62	0.09	0.92	Insignificant

HIP EXTENSOR STRENGTH:

Intra group analysis of hip extensor strength showed improvement in both the groups. Hip extensor strength has increased from **8.7±0.83 to 9.26±1.50** ($p<0.05$) in Group-A and from **9.53±1.48 to 9.91±1.46** ($p>0.05$) in Group-B. This improvement was statistically significant in Group-A, but insignificant in Group-B (Table-4).

Table-4: Intra group analysis of hip extensor strength of group A& Group B

	Pre (in Kg)	Post (in Kg)	t value	p value	Significance
Group-A (n=15)	8.7±0.83	9.26±1.50	-2.42	0.02	Significant
Group-B (n=15)	9.53±1.48	9.91±1.46	-2.11	0.053	Insignificant

LOWER EXTREMITY FUNCTIONAL SCORE (LEFS):

An increase in LEFS was found in Intra group analysis. It has increased from **36.86±7.98 to 60.93±7.02 ($p<0.05$)** in Group-A and from **42.73±6.07 to 56.86±8.99 ($p<0.05$)** in Group-B. This increased LEFS was statistically significant in both the groups (Table-5).

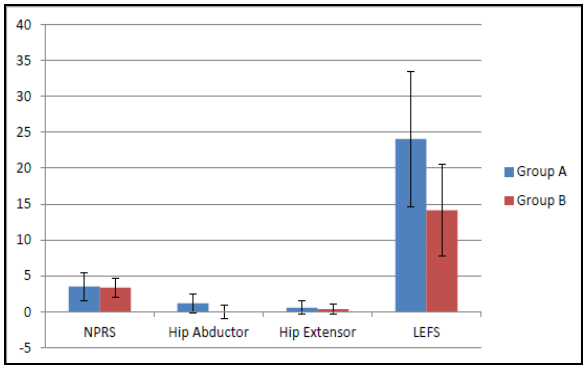
Table-5: Intra group analysis of LEFS of group A

	Pre	Post	t-value	p-value	Significance
Group-A (n=15)	36.86±7.98	60.93±7.02	-9.86	0.00	Significant
Group-B (n=15)	42.73±6.07	56.86±8.99	-8.58	0.00	Significant

An Independent sample t-test was used for between group measurements of NPRS, Hip abductor & Extensor strength and LEFS by using the mean difference obtained from the study. It was observed that mean difference of NPRS and Hip Extensor strength between two groups showed ($p>0.05$) statistically non-significant result, whereas, Hip Abductor strength and LEFS showed ($p<0.05$) statistically significant difference between two groups (Table: 6, Graph: 1)

Table-6: Inter group analysis of NPRS, Hip Abductor and Extensor strength & LEFS

VARIABLES	**Group A** (n=15) Mean difference	**Group B** (n=15) Mean difference	**t value**	**P value**	**Significance**
NPRS	3.53±1.95	3.33±1.39	0.32	.750	Insignificant
Hip Abductor	1.18±1.28	0.02±.90	-2.964	.006	Significant
Hip Extensor	0.56±.90	0.37±.69	-0.63	.533	Insignificant
LEFS	24.06±9.44	14.13±6.37	-3.37	.002	Significant



Graph-1: Inter group analysis of NPRS, Hip abductor & Extensor strength and LEFS

DISCUSSION

Piriformis syndrome is a neuro-muscular disorder which occurs when the piriformis muscle compresses the sciatic nerve. This flat, band like muscle located in the buttocks near the top of the hip joint. This muscle is important for lower body movement because it stabilizes the hip joint and lifts & rotates the thigh and lateral rotate the body. This muscle enables to walk and shift the body to another limb.

The subjects who participated in these study adults ranged from 30 to 50 years of age due to higher prevalence of piriformis syndrome in this age group. This study showed pain intensity and lower extremity functional score improvement in majority of subjects in each treatment intervention group.

The results showed no improvement in hip abductor and extensor isometric strength in Group B, but Group A subjects showed improvement. The data showed an improvement in both intervention group on pain intensity and LEFS but the improvement was statistically insignificant between Group-A and Group-B in terms of pain intensity, hip extensors isometric strength. The results showed significant improvement in hip abductor isometric strength and lower extremity functional scale (LEFS) in Group-A than Group-B after 10 sessions of treatment. With respect to pain intensity on numerical pain rating scale (NPRS) both groups showed statistically significant reduction after 10 sessions of treatment intervention. But, when compared between Group- A and B using mean differences, it showed statistically insignificant result.

Jason M. Beneciuk et al (2009) demonstrated that neuro-muscular tensioning had an immediate hypoalgesic effect on C-fibre mediated pain perception (temporal summation), but not on A-delta fibre mediated pain perception. [16]

Butler in the year 1991 recommends that neural mobilization may be viewed as another form of manual therapy similar to joint mobilization. This helps to mitigate pain and improves the mechanical adaptability of nervous system allowing the body to move with less resistance. In addition, nerve mobilization reduces scar tissue within the nervous system directly reducing pain. In order to pay heed to it manual method should be used by restoring the mechanical function of impaired neural tissue (intra and extra neural impairment) in the lumbo-pelvic lower limb complex

According to Shacklock mobilization (1995) of the nervous system is an approach to physical treatment of pain. The method relies on influencing pain physiology via mechanical treatment of neural tissues and the non-neural structures surrounding the nervous system. [7]
Sciatic nerve mobilization and piriformis stretching were given in both the groups which helped in reducing pain, so in between group analysis it didn't showed any statistically significant difference.

The data of the study showed statistically significant improvement in hip

abductor isometric strength ($p < 0.05$) and hip extensor isometric strength ($p < 0.05$) in Group-A, while there is statistically insignificant improvement in hip abductor ($p > 0.05$) and hip extensor ($p > 0.05$) isometric strength in Group-B. But, while comparing between Group A and Group B using mean difference the result showed statistically significant ($p < 0.05$) difference for hip abductor strength and statistically insignificant ($p > 0.05$) difference for hip extensor strength.

Pyka G. et al [17] (1994)conducted a study and found that prolonged moderate to high intensity resistance training may be carried out by healthy older adults with reasonable compliance and that such training leads to sustained increases in muscle strength. These improvements were rapidly achieved and were accompanied by hypertrophy of both type 1 and type 2 muscle fibres. They had previously shown that elderly women undergo type 2 fibre hypertrophy after a 12-week strength training period.

Joseph M. McBeth [14] (2012) conducted a study using electromyography (EMG) have shown that the gluteus medius is most active during a single-plane, side-lying hip-abduction (ABD) exercise as compared with a variety of other exercises. However, they did not include the tensor fascia lata (TFL), which is also a primary hip abductor; therefore, the contribution of the TFL to this exercise is not known.

From this study it was observed that there is statistically significant improvement of functional status in both the Group-A ($p < 0.00$) and Group-B ($p < 0.00$) after 10 session of treatment. But while comparing between Group-A and Group-B there was statistically significant ($p < 0.05$) difference in functional status (LEFS).

According to Gladson R. F. Bertolini et al (2009) [18] the neural mobilization technique was used to regain the movement and elasticity of the nervous system, with the objective of improving neurodynamics and re-establishing axoplasmic flow, thus restoring nerve tissue homeostasis, which promotes the return to its normal functions.

Chandler M. J. et al [19] (1998) conducted a study a found that strength loss is strongly associated with functional decline and is reversible with exercise. They examined the correlation between changes in lower extremity strength and changes in physical performance and disability in a frail community-dwelling population using progressive resistive strength training delivered in the home. Lower extremity strength gain was associated with gains in chair rise performance, gait speed and in mobility tasks such as gait, transfers, stooping and stair climbing, but not with improved endurance, balance or disability.

A statistically significant ($p < 0.05$) difference of lower extremity functional score has been observed after the 10th session of treatment in both the Group A and Group B. As, the pain decreased, the function also got improved in subjects of both the groups. In between group analysis, statistically significant ($p < 0.05$) difference was found in terms of function

CONCLUSION

This study demonstrated significant improvement in pain and functional status of both the groups and hip abductor & extensor strength only in Group A. In between group analysis Group A showed statistically significant improvement on Hip abductor strength and LEFS compared with Group B. Overall analysis of the data demonstrated that Hip abductor and extensor strengthening along with neural mobilization and piriformis stretching have significant effect on improving hip abductor strength and lower extremity function when compared with neural mobilization and piriformis stretching alone.

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Limitations and suggestions:

This is a single centred study with a small sample size, without any follow up period. No

blinding was done and no absolute control group was taken. Future double blind multicentre studies may be conducted with more number of subjects and long follow up period to find out long term efficacy.

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