



Effectiveness of Hip Muscle Strengthening and Backward walking in Piriformis Syndrome

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ABSTRACT

Aim: Piriformis syndrome is a group of symptoms and signs of pain from the piriformis muscle and is considered by pain in the buttock with variable involvement of the sciatic nerve. The aids of neural mobilization and piriformis stretching are commonly described and are known, but the effects and role of hip abductor and extensor strengthening along with backward walking is not well described. This study aimed to assess the effectiveness of hip muscle strengthening and backward walking in piriformis syndrome as a pilot study.

Method and Materials: In total, 76 subjects with piriformis syndrome were randomly assigned into two groups (Group A and Group B). Subjects in group A (n=38) received hip abductor and extensor strengthening and backward walking along with neural mobilization and piriformis stretching whereas, group B (n=38) received only neural mobilization and piriformis stretching for four weeks. Pain intensity was measured by Numerical Pain Rating Scale (NPRS) and lumbar range of motion was measured using Universal Goniometer.

Results: This study showed a statistically significant improvement in both the groups for pain intensity. However, the pain severity was considerably reduced more in group A. Furthermore lumbar ROM improvement was seen significantly more in Group A.

Conclusion: The study demonstrated that hip abductor and extensor strengthening along with backward walking have an added efficacy in improving lumbar flexibility and decreasing pain when combined with neural mobilization and piriformis stretching exercises.

Keywords: Piriformis syndrome, Backward Walking, Piriformis, Muscle, Pain.

Background

Piriformis syndrome is a painful condition characterized by some symptoms including buttock or hip pain [1-3]. It 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. The Pain in the buttock that radiates down the leg is called sciatica. One possible cause of sciatica is piriformis syndrome [4]. Synonyms frequently used for piriformis syndrome are deep gluteal syndrome, extra spinal sciatica, wallet neuritis, etc [5]. In 1928 Yeoman presented piriformis syndrome for the first time as a cause of sciatic pain due to the close anatomical relationship between the piriformis muscle

and the sciatic nerve [6]. The term "piriformis syndrome" was first coined by Robinson in 1947 [7]. He acknowledged that sciatica is a symptom and not a disease, because it is seldom caused by primary neuritis, and he defined that the term piriformis syndrome should be applied to the type of sciatica that is caused by an abnormal condition of the piriformis muscle that is usually traumatic in origin. In this study he presented two cases and described the cardinal features of piriformis syndrome as follows: a history of trauma to the sacroiliac and gluteal regions, pain in the region of the sacroiliac joint, greater sciatic notch, and piriformis muscle that usually extends down the limb and causes difficulty with

walking, acute exacerbation of pain caused by stooping or lifting (and moderate relief of pain by traction on the affected extremity with the patient in the supine position), a palpable sausage-shaped mass, tender to palpation over the piriformis muscle on the affected side, a positive Lase`gue sign, and gluteal atrophy, depending on the duration of the condition.

The piriformis muscle is pyramid-shaped [8]. It originates from the anterior surface of the S2-S4 vertebrae, the gluteal surface of the ilium, and the capsule of the SI joint [9-10]. It runs laterally through the greater sciatic foramen, becomes tendinous, and inserts to the piriformis fossa of the greater trochanter of the femur [8]. The gluteal nerves and vessels, the sciatic nerve, and the posterior femoral cutaneous nerve pass below the piriformis muscle. Piriformis muscle is functionally involved with external rotation, abduction, and partial extension of the hip. [11-12]. Piriformis syndrome is caused through low physical activity, unhealthy lifestyle, and habituations of the patient as well as underlying inadaptability between the sciatic nerve and piriformis muscle [8]. It has been estimated that its prevalence in Chronic Low Back Pain (CLBP) patients varies between 5% and 36% [13]. Sciatic symptoms prevalence has been estimated 5.1% for males and 3.7% for females in people aged 30 years and over. Piriformis syndrome diagnosing delay may lead to sciatic nerve pathologic conditions, chronic somatic dysfunction, pain due to compensatory changes, paraesthesia, hyperesthesia, and muscle weakness [4]. There are two kinds of piriformis syndrome- primary and secondary by which the primary piriformis syndrome causes by an anatomical reason while the secondary piriformis syndrome occurs when there is a microtrauma, ischemic mass or local ischemia. Fewer than 15% of piriformis syndrome patients

suffer from primary type. However, in most commonly cases about 50%, microtrauma to the buttocks is the main reason of this disease which cause inflammation and spasm leading to nerve compression [3]. Overuse of the piriformis muscle or its direct compression like wallet neuritis could be led to microtrauma. When the piriformis becomes tight it leads to pressure on the sciatic nerve causing irritation and sending pain down the back of the leg (sciatica) [14]. Furthermore, shortened piriformis can compress the sciatic nerve and a muscle held in a prolonged shortened position is liable to undergo weakness. Muscle shortening also increases the wear and tear-producing stretch effect on its tendon and leading to weakness, inflammatory and degenerative changes. It has been discussed that continuous loading of the piriformis muscle through over-lengthening and eccentric demand may lead to hip musculature weakness [4].

The most common physical therapy interventions consist soft tissue mobilization, piriformis stretching, hot packs or cold spray, and various lumbar spine treatments [15]. Neural mobilization has been applied to produce mechanical effects on nerve strain and excursion and has been considered as one of the theoretically modes of therapy for piriformis syndrome [15]. In this therapy, sliding techniques involve combinations of movements that lead to elongation of the nerve bed at one joint while reducing of nerve bed length bed at an adjacent joint has occurred which theoretically plays a role in dispersion of inflammatory products and limiting fibroblastic activity. Piriformis syndrome remains a controversial and nebulous diagnosis for back and buttock pain which could be a reason for unclear consensus on its definition and pathophysiology [1]. Many authors have recognized hip abductor muscle weakness as an associated finding with

piriformis syndrome. Strengthening of the muscles is needed to reduce strain on the piriformis muscle. Backward walking leads to greater activation of paraspinal muscles along with global extensor, activity of core extensor. Moreover, backward walking promotes hamstring and low-back flexibility under the hamstring pre-stretch mechanism. It can decrease LBP and increase the range of lumbar spine motion. There are few kinds of literature evidence available that can show the efficacy of hip abductor and extensor strengthening along with backward walking on pain and range of motion of the low back. Thus, the purpose of the present study is to find out the effectiveness of hip abductor strengthening and backward walking on piriformis syndrome.

Method and Materials

In this study, firstly subjects were approached and those fulfilling the inclusion criteria were selected. Inclusion criteria were both male and female subjects with 25 to 45 years of age with piriformis syndrome, grade 1-3 tenderness at the insertion of piriformis muscle. The subjects were excluded if they had any disc pathology, congenital or acquired abnormality in spine, pre-diagnosed musculoskeletal abnormalities and psychologically impaired problems. The procedure was explained to the probably participants and written informed consent was taken from those willing to participate. They were explained about pattern of study, need for study, information generated out of the study, importance about the information generated, its effect on general population. The subjects were explained about the benefits of the treatment. Moreover, they were informed about the free treatment procedure. Then Demographic information of the subjects was taken. The outcome measures were assessed prior to treatment session and after 4 weeks of completion of

intervention session. Total 76 subjects were taken for the study. The sample size was derived by the following formula using the help of statistician.

Formula: $p = \text{prevalence}$ (prevalence of piriformis syndrome among chronic low back pain patients that is between 5%- 36%), $q = 1 - p$ and $L = \text{allowable error}$

This was a comparative pilot study and consecutive simple random sampling method was applied to select eligible subjects.

Considering the inclusion/exclusion criteria, the 76 eligible subjects were randomised into two groups (Group A and Group B). Thus 38 subjects were allocated in each group by simple random sampling method. Both groups completed the demographic data at baseline. For each subjects the data for pain intensity and lumbar range of motion goniometry were taken pre intervention and at the end of the 4th week of the treatment session. The measurement of pain intensity was done by using Numerical Pain Rating Scale (NPRS). Subjects were explained about the scale and instructed to "indicate the intensity of current, pain rate on a scale of zero (no pain) to ten (worst pain). The measurements were taken at pre-intervention and post-intervention after the end of 4 weeks of intervention.

For measurement of lumbar flexion and extension, Universal Goniometer was used. This measurements were also taken at pre-intervention and post-intervention after the end of 4 weeks of intervention.

All the subjects of the group A were treated by hip abductor and extensor muscle strengthening, backward walking along with sciatic nerve mobilization and piriformis stretching. Three sets of hip abductor and extensor muscle strengthening exercises in a day, for 10 seconds maintenance in each exercise which repeated for 10 times and were done 5 days per week, for 4 weeks.

Backward walking was done for 15-30 mins in the speed which the subjects were comfortable with for 4 weeks.

For hip abductor strengthening, subject's position was in side-lying with affected side upward. Weight cuff was tied to the affected leg. Subjects were instructed to lift the upper leg towards the ceiling.

For hip extensor strengthen, subject was in prone lying position keeping both the ankle out of the couch. The affected leg was tied with the weight cuff around the leg. Subjects were instructed to lift the leg towards the ceiling.

Back walking program consisted of 10 min of back walking training with 5-min warm-up and cool-down sessions 5 days a week for 4 weeks at their comfortable walking speed. After the initial training, the participants were instructed to continue to practice for the remaining time (till week 4) and gradually increase their walking time up to 30 min.

Sciatic nerve mobilization was given for 30 second 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. The whole treatment was continued for 4 weeks.

For piriformis stretching, 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 contralateral 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.

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

Statistical analysis of the recorded data was done by using the software SPSS version 20. Arithmetic mean and standard deviation was calculated for each outcome measure. Arithmetic mean was derived from adding all the values together and dividing the total number of values. MS Excel was used for drawing various graphs with given frequencies and the various percentages that were calculated with the software.

Paired sample t test was used to analyse the intra group variables for NPRS, lumbar flexion and lumbar extension. Unpaired sample t test was used to analyse the inter group variables for NPRS, lumbar flexion and lumbar extension.

Findings

In this study, total 76 subjects were evaluated with Piriformis syndrome and were randomly divided into two groups (Group A and Group B with 38 subjects in each group). Group A with mean age of 30.76 ± 8.02 years included 22 men and 16 women and group B with mean age of 31.25 ± 6.90 included 20 men and 18 women. Analysis of demographic details, age and gender revealed that there was statistically insignificant difference between group A and group B at baseline $p > 0.05$.

Every subject after inclusion was assessed for intensity of pain by using NPRS. Subjects were instructed to indicate the intensity of

Table 1) Intra group comparison of pain intensity of boupsoth gr

Pain intensity	Pre intervention	Post intervention	t-value	p-value
Group A (Mean+SD)	5.13±0.74	2.31±0.57	25.089	0.0001
Group B (Mean+SD)	5±0.81	4.27±1.109	5.84	0.0001

Table 2) Intra group analysis of Lumbar flexion of both groups

	Pre intervention	Post intervention	t-value	p-value
GoupA (Mean+SD)	49.10±3.43	57.97±1.49	21.017	0.0001
Goup B (Mean+SD)	49.15±2.88	50.05±3.23	6.147	0.0001

Table3) Intra group analysis of Lumbar extension of both groups

Groups	Pre intervention	Post intervention	t-value	p-value
Group A (Mean+SD)	20.28±1.11	24.34±0.66	26.907	0.0001
Group B (Mean+SD)	20.22±1.656	21.72±1.358	7.779	0.0001

Table 4) Inter group analysis of NPRS, Lumbar flexion and lumbar extension

Studied outcome variables	Group A Mean difference	Group B Mean difference	t-value	p-value
NPRS	2.31±0.57	4.27±1.109	9.941	0.0001
Lumbar flexion	57.97±1.49	50.05±3.23	14.08	0.0001
lumbar extension	24.34±0.66	21.72±1.358	10.97	0.0001

current pain rate on the scale from score 0 as no pain to score 10 as worst pain. This was measured at pre-intervention and at 4 weeks post intervention.

Intragroup comparison revealed that there was reduction of pain intensity in both groups. Pain intensity decreased from 5.13±0.74 to 2.31±0.57 in group A and from 5±0.81 to 4.27±1.109 in group B. This reduction was statistically significant in both the groups (Table 1).

Intragroup analysis of lumbar flexion showed that lumbar flexion was increased in group A from 49.10±3.43 to 57.97±1.49 whereas subjects in group B did not showed much increase which was from 49.15±2.88 to 50.05±3.23. Change in Group A and Group B were statistically significant (Table 2).

Intragroup analysis of lumbar extension showed that lumbar extension was increased in group A and in group B but the changes were barely seen in the group B subjects.

The change in group A and group B was significant (Table 3).

An unpaired t test was used for between group measurements of NRPS, Lumbar flexion and Lumbar extension. By using the mean difference obtained from the study, it was observed that mean difference of NPRS, lumbar flexion and lumbar extension is significant (Table 4).

Discussion

Piriformis syndrome is a disorder which occurs when the tightness of piriformis muscle causes compression of the sciatic nerve. This muscle is located in the buttock near the top of the hip joint. It stabilizes the hip joint and lifts and rotates the thigh and lateral rotates the body. Hence it is an important muscle for lower body movement. The subjects who participated in this study ranged from 22 to 45 years of age

due to higher prevalence of the piriformis syndrome in this age group.

This study showed decrease pain intensity and increase lumbar range of motion in majority of the subject in each treatment intervention group. Furthermore, this study showed little improvement in lumbar flexion and extension range of motion in group B, but group A subjects showed significant improvement. The data showed an improvement in both groups regarding pain intensity but the improvement was comparatively much more in group A.

The result showed significant improvement in lumbar flexion range of motion and lumbar extension range in group A more than group B after 10 sessions of treatment. With respect to pain intensity on numerical pain rating scale (NPRS), group A showed statistically significant reduction after tenth session of treatment intervention. According to previous study on prevalence of tightness in hip muscle in middle age Indian men engaging in prolonged desk job, it was shown that out of 120 subjects 96.7% of them were found out to have tight hamstrings whereas 83.8% showed tight iliopsoas and 38% had piriformis tightness. This study concluded the hamstrings, iliopsoas, piriformis are the main muscles which can go for tightness after a prolonged period of sitting [16].

Backward walking enhances hamstring and lower back flexibility by virtue of hamstring pre-stretch mechanism. Backward walking can decrease LBP and increase range of motion of lumbar spine which gets affected in most of the people with piriformis syndrome. Rehabilitation program for the relief of LBP includes complex exercises such as, motor control exercises, muscle strengthening exercises, muscle stretching exercises and aerobic exercise. Though all these exercises cannot be done in the painful condition or in the acute stage as it cannot be tolerated by few

people or can increase the pain in some of the people. But backward walking can be initiated during the painful active stage as it does not aggravate any further pain and can be performed easily. Backward walking possesses higher neuromuscular demand on the body than forward walking in part because of its association with greater cadence and shorter stride length. In the study lumbar muscle activation patterns during forward and backward walking in participants with and without CLBP and electromyographic study concluded that backward walking led to greater activation of spinal muscle along with global extensors, activity of core extensors is also higher during backward walking. These findings may have important clinical implication in the rehabilitation of CLBP patients.

Yeoman, based on the intimate anatomic relationship of the Sacroiliac Joint (SIJ), the piriformis muscle, and the sciatic nerve, reported that sciatica may be caused by a so called "periarthrosis" involving the anterior sacroiliac ligament, the piriformis muscle, and the adjacent branches of the sciatic nerve [2]. In previous study it was acknowledged that biochemical irritation of the sciatic nerve epineurium may play a role in the pathogenesis of sciatica [3].

Piriformis syndrome can be associated with distal aetiologies such as hamstring syndrome and ischio-femoral impingement. Prevalence of Piriformis syndrome among CLBP patients is between 5 to 36%. Low back pain is multifactorial dysfunction with one of the potential contributing factors being the hip joint. Hip function has been proposed to be related to LBP because of the anatomical proximity of hip and lumbopelvic region. Hip range of motion has been studied in people with LBP and because of the limitation in hip motion it could alter the mechanical forces on the lumbopelvic region and can contribute to lower back pain. Incorporating backward

walking under such conditions which is seen in piriformis syndrome can help reduce the LBP and increase the lumbar flexibility.

In present study it could be argued that hip abductor strengthening exercises is needed in treatment of piriformis syndrome. Therefore, a treatment program addressing hip muscle strengthening and backward walking to control the femur in frontal plane during functional activities and to increase lumbar range and decrease pain might play a role in the treatment of subject with piriformis syndrome. As the pain decreases the function also gets improved in subjects. Many authors have recognised hip abductor weakness as an associated findings in piriformis syndrome.

Conclusion

The study demonstrated significant improvement in pain and lumbar range of motion in group A as compared to Group B. Overall analysis of the data demonstrated that hip muscle strengthening and backward walking have significant effect on improving lumbar range of motion and decreasing lower back pain when compared with neural mobilization and Piriformis stretching alone.

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Authors' contribution: AP conducted all stages of this study, wrote the first draft of the manuscript and verified it. PP participated in all stages of the study.

Conflict of Interest: There is no conflict of interest for this study.

Ethical Permission: All ethical principals were considered in this study. All participants were informed about the study. They participated voluntarily in the study and signed the consent form.

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