Original Article

The Effectiveness of Shoe Lift Insertion and High-Intensity Laser Therapy on Reducing Pain Intensity in Piriformis Myofascial Pain with Functional Leg Length Disparity

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Abstract

Introduction: *Myofascial pain in the piriformis muscle associated with functional leg length disparities (LLD) in patients with non-specific low back pain (NSLBP) is often undetected, resulting in inappropriate management. High-intensity laser therapy (HILT) is a noninvasive modality for treating piriformis syndrome. However, correction of leg length with the insertion of a shoe lift is also necessary as an adjunctive treatment. This study aims to assess the effectiveness of HILT with and without the use of shoe-lift inserts in reducing myofascial pain in NSLBP patients with LLD.*

Methods: *This single-blind, randomized clinical trial was conducted at the Medical Rehabilitation Clinic of Pasar Minggu General Hospital, Jakarta, from December 2022 to August 2023. Inclusion criteria were adult age, who endured NSLBP for 3-6 months, have LLD, and have myofascial pain in the piriformis muscle with a numerical rating scale (NRS). The Pelvic tilt was measured using an inclinometer. NRS scores in the treatment and control groups were calculated from week 1 to week 4.*

Results: *This study involved 26 subjects assigned to intervention and control groups. The average age was 49.8 years, and 69% of them were female. There was no significant difference in pelvic tilt between groups ($p=0.39$). The decreasing NRS scores were lower in the intervention than in the control group during the first and second weeks ($p=0.015$ and $p<0.001$). There was no significant difference in NRS scores between the second and third weeks in intervention and control groups ($p=0.157$ and $p=0.06$), however, the control group showed a tendency to increase NRS scores in the third week.*

Conclusion: *HILT combined with shoe lift insertion is more effective in reducing the intensity of piriformis myofascial pain in patients with NSLBP and LLD.*

Keywords: *Piriformis myofascial pain, Low back pain, Leg length disparity, High-intensity laser therapy, Shoe lift insertion.*

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Efektivitas Insersi Penyangga Sepatu dan Terapi Laser Intensitas Tinggi Terhadap Penurunan Intensitas Nyeri pada Nyeri Myofascial Piriformis dengan Disparitas Panjang Tungkai Fungsional

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Abstrak

***Pendahuluan**: Nyeri miofasial piriformis pada disparitas panjang tungkai fungsional (leg length disparities/LLD) pada pasien nyeri punggung bawah non-spesifik (non-specific low back pain/NSLBP) seringkali tidak terdeteksi sehingga tidak mendapatkan penanganan yang tepat. Terapi laser intensitas tinggi (high intensity laser therapy/HILT) merupakan modalitas non-invasif pada sindrom piriformis. Namun, koreksi panjang tungkai dengan insersi penyangga sepatu juga diperlukan sebagai tata laksana penunjang. Penelitian ini bertujuan untuk menilai efektivitas HILT dengan dan tanpa insersi penyangga sepatu dalam menurunkan nyeri miofasial pada pasien NSLBP dengan LLD.*
***Metode**: Uji klinis acak tersamar tunggal ini dilakukan di Klinik Rehabilitasi Medik di RSUD Pasar Minggu, Jakarta, pada Desember 2022 hingga Agustus 2023. Kriteria inklusi adalah usia dewasa, yang menderita NSLBP selama 3-6 bulan, memiliki LLD, dan nyeri miofasial piriformis dengan skor numerical rating scale/ NRS. Derajat kemiringan panggul diukur dengan inclinometer. Skor NRS pada kelompok perlakuan dan kontrol diukur dari minggu ke-1 hingga ke-4.*
***Hasil**: Studi ini melibatkan 26 subjek dibagi ke dalam kelompok perlakuan dan kontrol, dengan rerata usia 49.8 tahun, dan 69% perempuan. Tidak terdapat perbedaan derajat kemiringan panggul antara kedua kelompok ($p=0.39$). Penurunan milai NRS terjadi pada kedua kelompok, tetapi lebih rendah pada kelompok perlakuan pada minggu pertama dan kedua ($p=0.015$ dan $p<0.001$). Terdapat kesamaan NRS pada minggu ke-2 dan ke-3 pada kedua kelompok perlakuan dan intervensi ($p=0.157$ dan $p=0.06$), tetapi pada kelompok kontrol terjadi kecenderungan peningkatan NRS pada minggu ke-3.*
***Kesimpulan**: HILT yang dikombinasikan dengan insersi penyangga sepatu lebih efektif dalam menurunkan intensitas nyeri miofasial piriformis pada subjek NSLBP dan LLD.*

***Kata Kunci:** Nyeri myofasial piriformis, Nyeri punggung bawah, Disparitas panjang tungkai, Terapi laser intensitas tinggi, Insersi penyangga sepatu.*

Introduction

Piriformis myofascial pain is a common condition caused by contraction (spasm) of the piriformis muscle, characterized by deep pain in the gluteal region that radiates to the ipsilateral lower back and posterior thigh. This condition is often undetected and misdiagnosed.[1,2] According to expert consensus, myofascial pain is diagnosed based on three criteria for identifying Trigger points (TrP): the presence of tight bands, hypersensitive points, and radiating pain. At least two of the three criteria must be present to establish a diagnosis of myofascial pain. Radiating pain is pain that originates at the TrP and is felt at a distance from it. This phenomenon is due to complex sensory and motor responses such as pain, tenderness, increased motor unit activity, spasm, vasoconstriction, and hypersecretion, all of which are caused by TrP.[3]

The incidence of piriformis syndrome, which occurs when there is compression on the sciatic nerve, has a prevalence of between 5 and 36% in non-specific low back pain (NSLBP), which is pain that does not originate

from organic pathologies, such as tumors, infections, trauma, spondylolisthesis, rheumatic spinal diseases, and other definitive causes.[2,4] Piriformis myofascial pain is most common in the 4th and 5th decades of life, particularly in middle-aged patients (with a mean age of 38 years).[2]

Leg length discrepancy (LLD) can potentially be a risk factor for developing NSLBP, including piriformis syndrome. However, the relationship between these variables and the underlying mechanism remains questionable and has not been widely studied.[5,6] A study in chronic NSLBP patients (n=1309) found almost one-fifth of the subjects had LLD of more than 9 mm compared to the control group, who did not have a history of NSLBP.[6,7] In a smaller study of NSLBP patients (n=10) with an LLD of 10 mm, increased pain was observed when standing for 20-30 minutes, and the pain disappeared immediately when the patient sat down.[6]

Correction of LLD in cases of piriformis muscle myofascial pain is necessary to normalize the length of the piriformis muscle thus decreasing the tension of the muscle. A simple method for correcting LLD is using a shoe lift inside the shoe on the shorter leg, which helps make the length of both legs more symmetrical. The thickness of the shoe lift varies between 10-20 mm for insertion inside the shoe on the shorter leg, or 30-60 mm for placement on the shoe's outsole. The size of the shoe lift is determined based on the additional leg length required to correct the LLD and achieve a more symmetrical biomechanical structure.[8,9]

Treatment of piriformis myofascial pain usually begins with conservative therapy, which involves improving posture, controlling inflammation, increasing tissue elasticity, and gradually strengthening the affected area. If there is no improvement, the therapy may be continued with invasive therapy, such as tissue injection or nerve release surgery.[10] Physical therapy is recommended and includes stretching exercises for the piriformis muscle, such as internal rotation stretching, hip flexion, and adduction. Extracorporeal shock wave therapy and laser photobiomodulation therapy (FBM) have also been shown to be an effective therapeutic option for piriformis myofascial pain.[11]

Laser photobiomodulation therapy (FBM) is a non-invasive and painless treatment method in contemporary physiotherapy that may have local and systemic effects. Photobiomodulation stimulates and inhibits the pain receptors in peripheral tissues, affects the immune system, and leads to vasodilation and analgesic effects. FBM is widely used to reduce patient pain and stimulate the regeneration of damaged tissue and peripheral nerves. Laser therapy can stimulate the regeneration of damaged tissue and peripheral nerves.[10] One type of FBM therapy is high-intensity laser therapy (HILT), which has a photochemical effect that stimulates mitochondrial oxidation and ATP formation by channeling energy into the tissue. The therapeutic effect of HILT promotes rapid absorption of edema and removal of exudates through increased metabolism and blood circulation. HILT therapy has been proven to have minimal side effects when applied according to indications and proper procedures.[11]

Based on the aforementioned description, it can be inferred that the treatment of piriformis myofascial pain is expected to be more effective when combined with LLD correction using shoe lift insertion. Considering the high number of undetected cases of piriformis myofascial pain attributable to LLD, it is important to identify a simple method applicable within clinical settings. This study aims to evaluate the effective therapy by comparing the effectiveness of a combined approach of shoe lift insertion and HILT with that of HILT therapy alone, in patients presenting with LBP, LLD, and myofascial pain in the piriformis muscle.

Methods

This is a single-blind randomized controlled trial involving adults with NSLBP and LLD, who also exhibit myofascial pain in the piriformis muscle. The participants were outpatients aged 18-64 years old presenting to the hospital with NSLBP as their primary complaint. The study included patients with NSLBP persisting for more than three months, but less than six months, who had a Numeric Rating Scale (NRS) score of 5 to 7. The NRS, which asks patients to rate the intensity of their current pain from zero ("no pain") to ten ("the worst pain"), is one of the most widely utilized instruments for pain assessment and screening. The exclusion criteria were a history of hip and/or lower extremity injuries, diabetic foot, bone and joint infection, bone metastases, and neuromuscular disease such as stroke. Patients were also assessed to ensure the absence of serious pathologies, red flags, or ischialgia syndrome, and there was no history of trauma to the spine or lower extremities. The research was conducted at Medical Rehabilitation Outpatient Services

in a Pasar Minggu Regional General Hospital in the Jakarta area from December 2022 to August 2023. The study received ethical approval from the Research Ethics Committee of Pasar Minggu Regional General Hospital, under protocol number 28/KEPK/RSUDPM/VII/2022.

Subjects were distributed into two groups randomly, with 13 subjects in each group. The intervention group received shoe lift insertion in the shoe on the shorter side of the leg, combined with HILT applied to the piriformis muscle. The control group received only HILT on the affected piriformis muscle. All subjects were required to wear ergonomic sports shoes for walking activities. All subjects were administered acetaminophen 500 mg, 2-3 times daily if they had pain during the first week of study. The subjects expected no need for analgetic on the second week of treatment.

A pelvic tilt assessment was performed by instructing the subject to stand upright. The examiner assessed the pelvic tilt from behind using a scoliometer and caliper. The degree of pelvic tilt was indicated by the ball indicator on the scoliometer held above of caliper, which reflects the angle of inclination.

In the treatment group, subjects were instructed to stand upright, after the examiner inserted a shoe lift inside the shoe on the shorter leg. The shoe lift material is made from polyethylene, which is allowed to maintain its form under pressure up to 80 kg. The shoe lift is available in various thicknesses, namely 5 and 10 mm (Figure 1). The thickness of the shoe lift was selected based on individual leg length discrepancy. Once the shoe lift was inserted inside a shoe on the shorter leg, subjects were asked to stand upright again. The examiner re-assessed pelvic tilt using the same method. Correction of the anatomical structure of the LLD and pelvic tilt was considered achieved if the scoliometer indicated a nearer zero point.

Assessment of piriformis myofascial pain was conducted by applying pressure with an algometer on the piriformis muscle. Radiating pain was noted when the algometer reached a maximum pressure of 4 kg. Additionally, pain intensity increased during hip endorotation, and the examiner observed a minimal limited range of motion in the hip joints' endorotation.

Treatment of HILT was administered at the intensity of 10.0 Watts and an energy density of 10 Joules/cm2 over an area of 25 cm2 for 5 minutes, twice a week, for a duration of 3 weeks. The HILT modality used was the BTL-6000, with a power output of 12 watts, a wavelength of 1,064 nm, and a penetration depth of up to 10 cm.

Both groups were instructed to perform piriformis muscle stretching exercises at home, specifically before bedtime and upon waking, with 10 repetitions for each side. Pain assessment was conducted weekly over three weeks, using the NRS to subjectively evaluate pain intensity.

Results

A total of 228 patients with NSLBP were evaluated. Among them, 26 patients (11.4%) had piriformis myofascial pain accompanied by LLD and met the inclusion criteria. These patients were then randomly assigned to intervention and control groups. Most of the subjects were women (69%), and the average age of the subjects was 49.8 years, with an age range of 23 to 57 years (see Table 1). The average thickness of the shoe lifts used in the treatment group was 7.7±2.6 mm, with 49% of participants fit with 5 mm and 51% fit with 10 mm shoe lift. There was no association between the side of piriformis myofascial pain and the lower pelvis (Table 2). The height of the shoe lift was adjusted to correct a 70% discrepancy in the shorter leg

Figure 1. Shoe Lift (10 mm and 5 mm) and Insertion of Shoe Lift

and was worn for eight hours per day. After the intervention for LLD using a shoe lift, the scoliometer indicator moved closer to the zero point. The intervention group was instructed to use the shoe lift while standing and walking.

Table 1. Subject Characteristics

Characteristics	Intervention (n=13)	Control (n=13)	p*
Gender			
Men (n=8.31%)	3 (37.5%)	5 (62.5%)	0.33
Women (n=18. 69%)	10 (55.6%)	8 (44.4%)	
Age (median, range) (years)	49.6 (23-54)	50.2 (30-57)	0.9
Height (mean±SD) (cm)	161.3±4.6	159.3±5.2	0.3
Body weight (mean±SD) (kg)	63.8±7.2	62.4±6.8	0.6
Body mass index (mean±SD) (kg/m2)	25.1±2.1	24.3± 2.4	0.4
Mean degree of pelvic tilt (mean±SD) (degrees)	4.35±0.7	4.58±0.64	0.39
Lower pelvic side:			
Left	8 (57%)	6 (43%)	0.348
Right	5 (41.7%)	7 (58.3%)	

**Saphiro wilk test*

Table 2. Correspondence of Piriformis Myofascial Pain to the Lower Pelvic

Lower pelvic	Intervention (n=13)	Control (n=13)	p*
Same side with lower perlvic	7 (58.3%)	8 (41.7%)	0.348
Different side with lower pelvic	6 (42.9%)	5 (57.1%)	

**Mann-Whitney test*

Table 3. The Differences in NRS Intensity Between Groups

Lower pelvic	Intervention (n=13)	Control (n=13)	p+
NRS 1 (*baseline*)	6 (5-7)	6 (5-7)	0.8
NRS 2 (1st week)	4 (3-5)	5 (4-6)	0.015*
NRS 3 (2nd week)	2 (0-3)	4 (3-6)	<0.001*
NRS 4 (3rd week)	2 (0-3)	5 (3-6)	<0.001*

**Mann-Whitney test. NRS, numerical rating scale.*

All subjects initially reported moderate pain intensity that varied with activity levels. Pain improved with rest, but worsened during standing and walking. Six subjects in each group took acetaminophen once daily due to NSLBP in the second week. However, by the third week, none of the subjects required acetaminophen.

Pain intensity decreased in both groups, with a greater reduction observed in the intervention group during the first week, second week, and third week (Table 3). Post-hoc analysis indicated that, in the control group, pain intensity decreased during the first week ($p<0.01$) and the second week ($p=0.014$). However, in the third week, pain intensity tended to increase ($p=0.06$). In contrast, the intervention group experienced a significant reduction in pain intensity during the first week ($p=0.001$) and the second week ($p=0.001$), with pain intensity remaining similar to the second week in the third week ($p=0.157$). There was a statistically significant difference between NRS 4 (3rd week) and NRS 1 (initial), both in the intervention group ($p=0.001$) and the control group ($p=0.002$).

Discussion

Our study found no significant differences in gender or age distribution between the two groups, although both had a higher proportion of females participants. This gender composition is consistent with previous research suggesting a higher prevalence of piriformis myofascial pain among women. The unique biomechanics in women, including a wider pelvic and an increased Q angle of the knee, may contribute to greater pressure on the piriformis muscle.[2]

In both the intervention and control groups, the mean age was 49.6 years (range 23-54) and 50.2 years (range 30-57), respectively. These findings are consistent with previous research indicating that piriformis myofascial pain is prevalent in the fourth and fifth decades of life. However, the average age in this study is higher than that reported in earlier studies, and the average age was 38

years.[10] The presence of piriformis myofascial pain associated with NSLBP and LLD is often undetected, leading to delays in diagnosis and appropriate treatment.[1]

The BMI of the two groups was relatively similar, however, the intervention group was obese category according to Asia-Pacific criteria. The mean degree of pelvic tilt was also comparable between the groups, with values of 4.35±0.7 and 4.58±0.64 degrees, respectively (p=0.39). These findings support previous studies that have identified LLD as a risk factor for NSLBP. LLD can lead to asymmetrical weight distribution between the pelvis and legs, resulting in chronic inflammation of the joints and pelvic muscles.[6,7]

Piriformis myofascial pain was found on the lower and higher sides of the pelvic. The distribution of piriformis myofascial pain on the higher and lower sides of the pelvic was similar and consistent in both groups (p=0.348). On the side of the shorter leg, there is an increased distance between the acetabulum and the femoral head, which leads to increased muscle tone and myofascial pain in the piriformis muscle. This increased tone is a compensatory response to the greater distance between the muscle's origin and insertion. Conversely, on the side of the longer leg, a similar but opposite mechanism can also contribute to increased piriformis muscle tone and resultant myofascial pain.[12-15]

The average thickness of the shoe lift used for LLD correction in the treatment group was 7.7±2.6 mm. Specifically, 6 subjects used a 5 mm lift, while 7 subjects used a 10 mm lift. This thickness is thinner compared to previous studies, which reported effective corrections with lifts of 10-11 mm.[14] The chosen thickness of the shoe lift is estimated based on the functional leg length difference. This approach is consistent with prior research, which has identified LLD differences of 6 mm or more as being associated with lower back pain.[7]

HILT is a form of photobiomodulation therapy that stimulates cells, including pain receptors in peripheral tissues and the immune system, leading to vasodilation and analgesic effects. This therapy is widely utilized to alleviate pain. Additionally, laser therapy promotes the recovery of damaged muscles and peripheral nerves through regenerative processes. HILT has a photochemical effect that enhances mitochondrial oxidation and ATP production by delivering energy into the tissue, resulting in the rapid absorption of edema and the removal of exudates through increased metabolism and blood circulation.[11,16]

We observed a decrease in pain intensity in both the intervention (HILT and shoe lift insertion) and control group (HILT alone). However, the reduction in pain was significantly greater in the intervention group in the first and second weeks. In this group, the shoe lift corrected the anatomical structure of the shorter leg, normalizing the length of the piriformis muscle during standing and walking activities. This correction led to reduced tension in the piriformis muscle during these activities. Normalizing the muscle tone of the piriformis increased blood circulation and reduced inflammation, subsequently decreasing pain intensity.[3,15]

By the third week, the control group's pain intensity increased, though not significantly compared to the second week. In contrast, the intervention group maintained pain levels similar to the second week. The control group showed an increase in pain intensity in the third week, suggesting a potential for continued worsening of pain in subsequent weeks. These findings highlight the tendency for NSLBP in subjects who have LLD to recur despite treatment. Increasing pain intensity due to an imbalance motion in the pelvis and hip during standing and walking in uncorrected LLD, and then followed by increased pressure on the piriformis muscle. The data from this study is in line with a previous study by Rannisto S, et al.[17], in 114 meat cutters who had LLD of at least 5 mm, and LBP intensity between 2-10 by Visual Analogue Scale. Subjects assigned to the intervention group were corrected by shoe lift, 70% discrepancy on shorter legs for eight hours per day. The workers in the intervention group had a higher improvement in LBP intensity, intensity of sciatic pain, increasing RAND-36 physical functioning, and a lesser likelihood of sick leaves, compared to the control group.[17] Another study by D'Amico M, et al.[18], has found the pain of NSLBP in subjects with LLD after correction by shoe lifts, significantly decreased in pain intensity, as well as improvement in all postural parameters, and no worsening of pain has been detected.[18]

The limitations of the study are the relatively wide range of subjects' ages, and the study did not analyze the association between the subjects' occupation and pain intensity before and after intervention. Further study is needed to analyze the biomechanic differences in spine-pelvic-extremity motion, and hip-knee-ankle motion before and after shoe lift intervention.

Conclusion

HILT combined with an appropriately thickened shoe lift, for correcting anatomical functional discrepancies of LLD is more effective in reducing pain intensity more permanently than HILT alone in subjects with NSLBP who have piriformis myofascial pain with LLD.

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