RESEARCH PAPER

A Comparative Study of Laser Therapy and Shockwave Therapy in the Treatment of Piriformis Syndrome: The Role of Exercise as an Adjunctive Treatment

Amany mohamed abd elhafez mohamed[1], Amira E. M. Abd ElHay[2], Mohamed M Elsharkawy[3], Sahar M. Abdelmutilibe[4], Rasha M. El-Marakby[5], Amira H. Mohammed[6], Ashwaq Alqahtani[7], Amal Alharbi[8], Saleh M. Aloraini[9], Feras Alsultan[10], Mohamed Mohamed Mazen[11], Abeer M. Yousef[12]

[1]Lecture of Physical Therapy for Internal Medicine and Geriatrics, Military Medical Academy. Email: amanypt74@gmail.com

[2]Faculty of Applied Medical Sciences, Rehabilitation Sciences Department, Al al-BAYT University, Mafraq, Jordan. Email: dr.amira.ezzat.pt@gmail.com / amira.ezzat@aabu.edu.jo
ORCID: 0009-0001-5000-5729

[3]Associate Professor, Ajloun National University, Ajloun 26810, Jordan. Email: m.sharkawi@anu.edu.jo
ORCID: 0009-0000-9810-2547

[4]Lecturer, Department of Physical Therapy for Musculoskeletal Disorders and Its Surgeries, Faculty of Physical Therapy, Beni-Suef University, Egypt. Email: sahar.mowad@pt.bsu.edu.eg
ORCID: 0009-0006-5037-3165

[5]Department of Physical Therapy, Faculty of Applied Medical Science, Irbid National University, Irbid, Jordan. Email: rashamarakby456@gmail.com
ORCID: 0009-0007-4132-0093

[6]Department of Physical Therapy, College of Applied Medical Sciences, Qassim University, Buraydah 51452, Saudi Arabia. Department of Physical Therapy for Pediatrics, Faculty of Physical Therapy, Delta University for Science and Technology, Gamasa, Egypt. Email: a.ebermbaly@qu.edu.sa
ORCID: 0000-0002-6018-9138

[7]Department of Physical Therapy, College of Applied Medical Sciences, Qassim University, Buraydah 51452, Saudi Arabia. Email: A.alqahtani@qu.edu.sa
ORCID: 0009-0009-4884-2251

[8]Department of Physical Therapy, College of Applied Medical Sciences, Qassim University, Buraydah 51452, Saudi Arabia. Email: ama.alharbi@qu.edu.sa
ORCID: 0009-0008-7260-5486

[9]Department of Physical Therapy, College of Applied Medical Sciences, Qassim University, Buraydah 51452, Saudi Arabia. Email: saloraini@qu.edu.sa
ORCID: 0000-0001-7939-8098

[10]Department of Physical Therapy, College of Applied Medical Sciences, Qassim University, Buraydah 51452, Saudi Arabia. Email: f.alsultan@qu.edu.sa
ORCID: 0000-0002-3470-8272

[11]Department of Basic Sciences, Faculty of Physical Therapy, Delta University for Science and Technology, Gamasa, Egypt. Department of Physical Therapy, College of Applied Medical Sciences, Qassim University, Buraydah 51452, Saudi Arabia. Email: Mmazen.pt@icloud.com
ORCID: 0000-0001-8969-7841

[12]Basic Science Department, Faculty of Physical Therapy, Cairo University, Egypt. Department of Physical Therapy, College of Applied Medical Sciences, Qassim University, Buraydah 51452, Saudi Arabia. Email: abeer.mahmoud28@yahoo.com / a.aboelaish@qu.edu.sa
ORCID: 0000-0002-2926-7660

ABSTRACT

Background

Chronic gluteal and lower back discomfort, often caused by piriformis syndrome, may severely limit a person's ability to carry out daily tasks. While there is encouraging evidence for the use of non-invasive modalities like radial extracorporeal shockwave therapy (rESWT) and low-level laser therapy (LLLT) to treat musculoskeletal conditions, there is a lack of comparative evidence regarding the efficacy of these therapies, particularly when combined with therapeutic exercise.

Methods

There were 70 participants in the experiment, split equally between two groups, and it was a prospective randomised controlled trial: Compare the Use of Shockwaves with Lasers for Exercise. Treatments were administered for a duration of four weeks. Baseline, post-treatment, and 3-month follow-up assessments of the following outcome measures were conducted: Visual Analogue Scale (VAS), Oswestry Disability Index (ODI), range of motion (ROM), and Short Form-36 (SF-36).

Results

There were significant improvements in pain and disability levels ($p < 0.001$) in both groups. There were significant time × group interactions for VAS, ODI, and hip ROM, and shockwave treatment produced better functional improvements in ODI (mean reduction: 15.80 vs. 11.71, $p = 0.049$) and hip ROM (mean increase: 15.43° vs. 9.91°, $p = 0.063$).

Conclusion

When exercised with LLLT or rESWT, piriformis syndrome may be safely and effectively treated. When compared to other methods, shockwave treatment improved functional recovery and mobility the most.

Keywords: Piriformis syndrome, shockwave therapy, laser therapy, physiotherapy, Oswestry Disability Index, range of motion, quality of life.

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Introduction

Low back and gluteal discomfort, as well as the underdiagnosed neuromuscular disorder piriformis syndrome, have major effects on functional ability and quality of life [1]. When the piriformis muscle presses on or irritates the sciatic nerve, a condition known as sciatica or lumbar radiculopathy develops. In everyday clinical practice, diagnosing and treating piriformis syndrome may be challenging due to its complex aetiology, which includes biomechanical abnormalities, muscle overuse, and postural instability [2].

As first-line therapies, conservative methods are often used in initial care. Some examples of these include physiotherapy, activity modification, posture training, NSAIDs, and other non-steroidal anti-inflammatory medicines [3]. Physical therapy, and therapeutic exercise in particular, are examples of conservative methods that have shown promise in alleviating painful muscle tension, re-establishing hip stability, and improving lumbopelvic mechanics. Nevertheless, interventional therapies like surgical decompression or corticosteroid injections may be undertaken when conservative management does not provide long-term relief, despite the dangers and uncertain results [4].

The use of non-invasive biophysical techniques such radial extracorporeal shockwave therapy (rESWT) and low-level laser therapy (LLLT) to treat musculoskeletal diseases has become more popular in recent years [5]. Long-lived light therapy (LLLT) makes use of targeted light wavelengths to promote mitochondrial function, decrease inflammatory mediators, and aid in tissue healing via photobiomodulation. On the flip side, rESWT improves cellular regeneration by stimulating neovascularisation, regulating nociceptors, and transmitting directed sonic energy to specific tissues. Several disorders, such as tendinopathies, myofascial pain syndromes, and joint dysfunctions, have shown encouraging responses to both approaches [6, 7].

Although there is mounting evidence that LLLT and rESWT may be effective on their own, there is a lack of direct comparison research on their effectiveness in piriformis syndrome. In order to optimise personalised treatment pathways and make decisions based on evidence, it is essential to understand their relative clinical efficacy [8].

In addition, these methods may work much better when combined with organised exercise treatment. Reducing mechanical tension on the sciatic nerve and improving neuromuscular control may be achieved by stretching and strengthening programs that target the piriformis muscle and surrounding stabilisers. It is possible to improve treatment results, speed up recovery, and decrease recurrence rates by combining these exercises with LLLT or rESWT [9].

In addition, a key part of treating musculoskeletal discomfort is exercise treatment. The strength, flexibility, and general functioning of a patient with a musculoskeletal injury or disease may be enhanced with specific exercises, which can enhance the efficacy of other therapies. It is possible to increase the efficacy and duration of pain relief from other treatments, such as laser or shockwave therapy, by including exercise into the patient's treatment plan [10, 11].

Patients with piriformis syndrome will participate in a randomised controlled experiment that compares the effectiveness of radial shockwave treatment with low-level laser therapy when combined with a

standardised exercise regimen. This study aims to fill a knowledge vacuum by comparing the two treatments for pain relief, functional improvement, joint mobility, and quality of life.Patients and Methods

This research is a prospective, randomised, controlled clinical trial that is being carried out in the physical therapy outpatient clinics of the Beni Suef University Department of Physical Medicine and Rehabilitation.

Study Population

Inclusion criteria:

A verified diagnosis of piriformis syndrome in adults (18–65 years old). A positive FAIR test and evidence of sciatic nerve involvement on EMG were necessary for piriformis syndrome to be diagnosed. Participants were considered eligible if they experienced persistent symptoms for a minimum of three months and initially scored 4 or higher on the Visual Analogue Scale (VAS) for pain.

Exclusion criteria:

In order to provide a fair and balanced study, we excluded participants with the following conditions: a history of lumbar spine, sacroiliac joint, or hip surgery; systemic inflammatory illnesses such rheumatoid arthritis or ankylosing spondylitis; neurological disorders that hinder the function of the lower limbs; or being pregnant or nursing. Patients undergoing treatment for cancer, haemophilia, or pacemaker insertion

Sample Size Calculation

The current study used a similar sample size estimation to that of a previous one that looked at spinal cord stimulation modalities for chronic pain (Billot et al., 2018). That study assumed a mean difference of 2 points on the Visual Analogue Scale (VAS) with a standard deviation of 2.5. Thirty patients are needed in each group in order to reach 80% power at a 5% significance level. We recruited 35 individuals for each group, for a total of 70 patients, after accounting for a possible dropout rate of 15% [12].

Interventions

Group A: Laser Therapy + Exercise

The low-level laser treatment (LLLT) group used a Class IV laser device (MLS Multiwave locking system, 808 nm wavelength, 1.5 W power) for 10 minutes each session, three times weekly, for four weeks, targeting the afflicted region. A standardised therapeutic exercise program was also implemented, with participants stretching and strengthening exercises aimed at the piriformis muscle and the stabilisers of the sacroiliac joint. In addition to the LLLT sessions, they should be done three times weekly for four weeks. To guarantee correct form, consistency, and safety, every session is overseen by a certified physiotherapist working in the physical therapy section.

Group B: Shockwave Therapy + Exercise

In the shockwave treatment group, patients had four sessions of 2000 pulses each, delivered by radial extracorporeal shockwave therapy (rESWT) (EME srl-via Degli Abeti 88/1 at 2.5 bar, 10 Hz). In addition, under the supervision of a physiotherapist, they were required to exercise three times weekly for four weeks following the same standardised program as Group A, which included strengthening and stretching activities.

Primary Outcome

Evaluation of the short- and mid-term effects of a 4-week and post-3 months intervention was carried out using the Visual Analogue Scale (VAS) for Pain Intensity. Endpoints were "no pain" and "worst imaginable pain," and scores were recorded at baseline, after 4 weeks, and after 3 months of follow-up.

Secondary Outcomes

1. Oswestry Disability Index (ODI) for Functional Impairment: This tool was used to evaluate functional impairment in cases of lower back pain and functional limitations. A higher score indicates a more severe impairment on the 10-item test that evaluates everyday activities.

2. ROM: A standardised goniometer was used to measure the active range of motion (AROM) in the lumbar spine and hips, which was then utilised to evaluate joint mobility. Sections C and D of the established orthopaedic range of motion procedures were followed throughout the assessment:

- Section C, "Hip Flexion," measures the extent to which the hips are bent when the subject is lying flat on their back.
- Section D, Lumbar Flexion, requires the patient to be in a standing posture and to be measured for forward spinal bending using either the fingertip-to-floor method or an inclinometer methodology.

Measurements taken at baseline, four weeks after therapy, and three months after treatment by the same physiotherapist to minimise variability across raters.

3. SF-36 Quality of Life Scale: A well-respected instrument that covers eight dimensions, the Short Form-36 (SF-36) questionnaire measures health-related quality of life. Two primary component scores were examined:

- • Physical Component Score (PCS): Indicates functionality, restrictions in roles as a result of physical health, feelings of discomfort in the body, and overall health.
- • The Mental Component Score (MCS) assesses energy levels, weariness, social functioning, role restrictions caused by emotional difficulties, and overall emotional health.

In order to track progress in physical and mental

health, participants will fill out the SF-36 at baseline, after 4 weeks, and after 3 months of follow-up.

Ethical Considerations

Beni Suef University's Physical Therapy Department's Institutional Review Board (IRB) has given its stamp of approval to the study's protocol (Approval No..FPTBSUREC/ 0212/15426). Prior to enrolment, all participants will be asked to give written informed permission. Good Clinical Practice and the Declaration of Helsinki will serve as the guiding principles for this investigation. NCT07567703 is the number of the clinical trial registration.

Statistical analysis

For each outcome measure, including VAS, ODI, ROM, and SF-36 scores, statistical analysis was carried out using repeated measures ANOVA to examine changes over time both within and across groups. To make sure the groups were equivalent, we used chi-square and independent t-tests to compare their baseline characteristics. Differential treatment effects were determined by analysing the effects of time × group interaction. It was deemed statistically significant if the p-value was less than 0.05. Results

There were no statistically significant changes in the demographic or clinical features of the 70 individuals who were randomly assigned to either the Laser + Exercise or Shockwave + Exercise groups (n = 35 each) (Table 1). There was suitable group matching at the beginning of the investigation since there was no significant difference in age, sex distribution, body mass index (BMI), or symptom duration between the groups.

Table 1: Baseline Characteristics of Participants

Variable	Laser + Exercise (n=35)	Shockwave + Exercise (n=35)	p-value
Age (years), mean ± SD	45.83 ± 10.05	44.89 ± 9.17	0.683
Sex (M/F), n	13 / 22	15 / 20	0.626
BMI (kg/m²), mean ± SD	25.10 ± 4.09	24.45 ± 3.48	0.473
Duration of symptoms (mo)	6.26 ± 1.96	5.57 ± 1.74	0.126

Table 2 shows that both groups' decreases over time were statistically and clinically significant. At baseline, after 4 weeks of follow-up, and after 3 months of follow-up, VAS scores dropped considerably in both groups, and there were statistically significant differences between the groups after treatments. Although the ODI scores were similar at the beginning, the shockwave group showed much more improvement by the third month (p = 0.049), suggesting that this modality may have some practical benefits.

Table 2: Pain and Disability Scores at Baseline, Post-Treatment, and Follow-Up

Outcome	Timepoint	Laser (mean ± SD)	Shockwave (mean ± SD)	p-value
VAS	Baseline	6.30 ± 1.24	6.35 ± 1.49	0.882
	Post 4 weeks	3.72 ± 1.65	4.30 ± 1.96	0.049
	3 Month	3.01 ± 1.70	3.56 ± 2.00	0.022
ODI	Baseline	43.43 ± 8.80	43.00 ± 9.36	0.844
	Post 4 weeks	31.71 ± 8.80	27.20 ± 10.32	0.053
	3 Month	30.91 ± 8.74	26.34 ± 10.31	**0.049**

With time, both groups showed improvements in hip and lumbar flexion (Table 3). There were near-significant differences found at 1-month follow-up (p = 0.043) and post-treatment (p = 0.041) in terms of hip range of motion increases between the shockwave group and the control group. On the other hand, there were statistically significant changes between the groups after treatments for lumbar flexion, which demonstrated small but comparable gains.

Table 3: Range of Motion (ROM) for Hip and Lumbar Spine

ROM Measure	Timepoint	Laser (mean ± SD)	Shockwave (mean ± SD)	p-value
Hip Flexion	Baseline	89.09 ± 10.90	88.37 ± 9.38	0.770
	Post 4 weeks	99.00 ± 11.44	103.80 ± 9.55	0.041
	3 Months	100.46 ± 11.36	105.14 ± 9.24	0.043

Lumbar Flexion	Baseline	39.40 ± 7.23	36.94 ± 10.32	0.253
	Post 4 weeks	40.80 ± 7.24	38.46 ± 10.28	0.0427
	3 Months	40.80 ± 7.24	38.46 ± 10.28	0.0374

Physical component scores (PCS) of the SF-36 improved in both groups, as seen in Table 4. At baseline, post-treatment, and 3-months, PCS continued to rise, and there was no statistically significant difference between the groups throughout ($p > 0.05$). Over the course of the research, both groups' mental component scores (MCS) showed no change, suggesting that their mental health was stable.

Table 4: SF-36 Quality of Life Scores

SF-36 Component	Timepoint	Laser + Exercise (mean ± SD)	Shockwave + Exercise (mean ± SD)	p-value
Physical Component (PCS)	Baseline	38.83 ± 5.50	37.83 ± 6.28	0.481
	Post 4 weeks	45.54 ± 6.37	45.09 ± 8.06	0.793
	3 Months	46.63 ± 6.35	46.00 ± 7.83	0.713
Mental Component (MCS)	Baseline	46.71 ± 5.10	44.09 ± 8.15	0.110
	Post 4 weeks	46.71 ± 5.10	44.09 ± 8.15	0.110
	3 Months	46.71 ± 5.10	44.09 ± 8.15	0.110

Table 5 shows the changes within each therapy group from baseline to the 3-month follow-up. In all groups, significant progress was seen as early as four weeks after therapy and continued until three months later. The delta between the two sets of data shows how much has changed from the beginning to the end of the three-month period. With a p-value of less than 0.001, the laser group not only improved hip and lumbar range of motion and PCS, but also significantly reduced VAS and ODI ratings. After four weeks of therapy, patients reported substantial improvements in pain, disability, hip range of motion (ROM), lumbar ROM (ROM), and PCS, which were either sustained or enhanced at the three-month follow-up. In addition to similar improvements in VAS, lumbar ROM, and PCS, the shockwave group showed significantly higher improvements in functional impairment (ODI: 15.80 points) and hip mobility (15.43°). Perceived mental health remained stable over the intervention period, as neither group showed any change in mental component ratings. At the 4-week mark, improvements in hip range of motion (ROM) and pain were noticeable in both groups, and these effects continued during the 3-month follow-up. However, at the 3-month mark, there were more significant disparities between the groups in terms of disability outcomes (ODI).

Table 5: Within-Group Pre-to-Post Treatment Changes at 3-Month Follow-Up

Group	Outcome	Mean Difference (Pre–Post)	95% CI	p-value
Laser + Exercise	VAS	2.58	2.21 to 2.95	< 0.001
	ODI	11.71	10.16 to 13.27	< 0.001
	Hip Flexion	9.91	8.23 to 11.60	< 0.001
	Lumbar Flexion	1.40	1.21 to 1.59	< 0.001
	Physical Component	6.71	5.52 to 7.91	< 0.001
	Mental Component	0.00	-	-
Shockwave + Exercise	VAS	2.05	1.65 to 2.45	< 0.001
	ODI	15.80	14.02 to 17.58	< 0.001
	Hip Flexion	15.43	13.41 to 17.45	< 0.001
	Lumbar Flexion	1.51	1.30 to 1.73	< 0.001
	Physical Component	7.26	5.74 to 8.77	< 0.001
	Mental Component	0.00	-	-

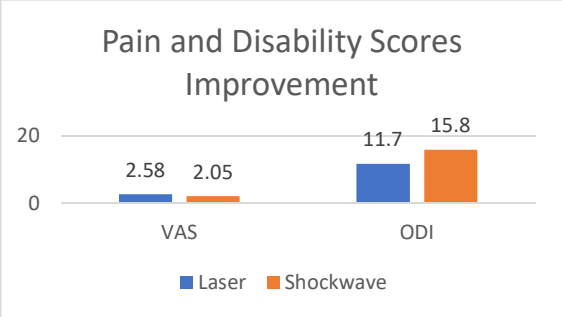

Figure 1: Pain and Disability Scores Improvement between both groups.

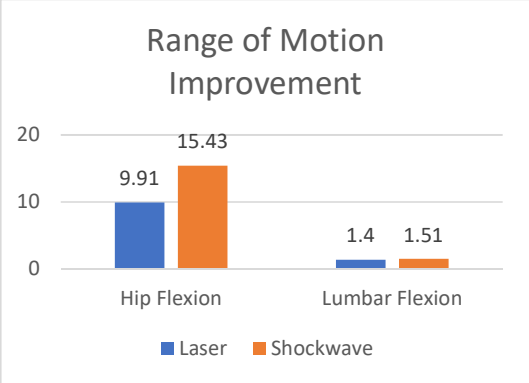

Figure 2: Range of Motion Improvement between both groups.

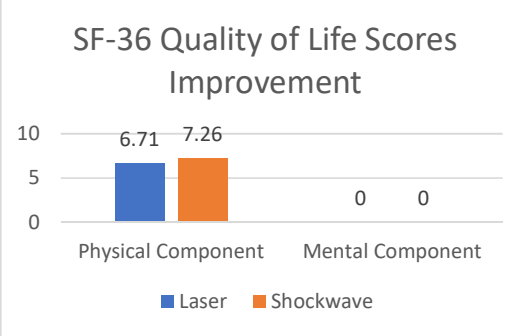

Figure 3: SF-36 Quality of Life Scores Improvement between both groups.

Summarised in Table 6 are the results of the repeated measures ANOVA. Both therapy regimens resulted in observable improvements throughout the research, as shown by a significant main impact of time ($p < 0.001$) for all outcomes except MCS. The degree and trajectory of improvement over time differed between the two groups, as shown by significant time × group interactions for VAS ($p = 0.029$), ODI ($p = 0.001$), and hip ROM ($p < 0.001$). The other three variables—lumbar range of motion (ROM), pelvic center of gravity (PCS), and MCS—did not show any significant interactions ($p = 0.415$, $p = 0.778$, and $p = 0.415$, respectively).

Table 5: Repeated Measures ANOVA for Time × Group Interaction

Outcome	Time Effect (p)	Group Effect (p)	Time × Group Interaction (p)
VAS	< 0.001	0.314	0.029
ODI	< 0.001	0.151	0.001
ROM Hip	< 0.001	0.227	< 0.001
ROM Lumbar	< 0.001	0.267	0.415
SF-36 PCS	< 0.001	0.657	0.778
SF-36 MCS	—	0.110	—

Discussion

Recognised as a leading source of gluteal and lower back discomfort, piriformis syndrome often leads to persistent musculoskeletal dysfunction and a reduced quality of life. The foundation of treatment continues to be conservative approaches, especially modalities based on physiotherapy. There has been a rise in interest in non-invasive methods with regenerative and analgesic promise, such as radial extracorporeal shockwave treatment (rESWT) and low-level laser therapy (LLLT). The purpose of this research was to evaluate the relative merits of LLLT and rESWT in treating piriformis syndrome in conjunction with a predetermined exercise regimen. The fact that the groups' baseline demographic and clinical features were similar shows that the randomisation was effective. The Oswestry impairment Index (ODI) showed statistically significant improvements in functional impairment in both treatment groups, although the shockwave group showed better results overall (mean improvement: 15.80 vs. 11.71 points; $p = 0.049$). The increased speed and extent of functional recovery shown with shockwave treatment is further supported by the substantial time × group interaction ($p = 0.001$). The results are consistent with what Tan et al. [13] found before. those who found that focused ESWT improved functional outcomes more than manual treatment, and those who found that rESWT improved quality of life and symptom resolution more quickly than corticosteroid injection (Ahadi et al., 2014).

Although both groups improved their hip ROM significantly, the rESWT group did so at a faster rate (15.43° vs. 9.91°), demonstrating their superior joint mobility. The substantial time × group interaction ($p < 0.001$) indicates that rESWT had a more powerful effect on re-establishing mobility, even if there were borderline between-group differences at the 3-month follow-up and post-treatment ($p = 0.063$ and $p = 0.061$, respectively). Evidence for this comes from the work of Nakanishi et al.[15], who found that sciatic nerve morphology improved and muscle stiffness reduced after rESWT. On the flip side,

there were no significant changes in lumbar flexion gains across the groups ($p = 0.415$), which is in line with other findings that indicate only a minor improvement in spinal mobility after LLLT [16].

The SF-36 Physical Component Score (PCS) was used to evaluate quality-of-life outcomes, and it was shown that both groups had equivalent gains: LLLT: +6.71 and rESWT: +7.26. These findings support the work of Starzec-Proserpio et al.[17] and Mohamed et al.[18], who also used lasers to improve musculoskeletal function. It is worth mentioning that the Mental Component Score (MCS) did not change between the two groups ($p = 0.110$). This is consistent with the results of Liu et al.[19], which imply that physical therapies are good at alleviating somatic symptoms, but they may not be able to improve psychological domains without incorporating cognitive-behavioral therapy.

The observed differences in outcomes might be explained by the mechanistic superiority of rESWT. Shockwave treatment boosts cellular regeneration by means of mechanotransduction, influences nociceptive pathways, and encourages neovascularisation. Taken together, these results provide credence to its analgesic and restorative capabilities. However, low-level light therapy (LLLT) improves mitochondrial function, decreases inflammation, and aids cellular tissue repair via photobiomodulation. One possible explanation for rESWT's superior clinical effectiveness, especially in enhancing mobility and functional status, is the difference in underlying processes. This agrees with the findings of previous studies that found ESWT to be more effective in treating musculoskeletal dysfunction, such as Ohkuin et al. [20] and Liu et al. [19].

Notably, no serious side effects were recorded throughout the course of the research, indicating that both therapies were well-tolerated. The positive safety profiles of these products are further strengthened, lending credence to their inclusion in interdisciplinary rehabilitation programs for piriformis syndrome. This study's lack of problems lends credence to the findings of Tan et al. [13] and Ahadi et al. [14], showing that their methods may be used in clinical settings.

Conclusion

In conclusion, piriformis syndrome patients who also undergo low-level laser or radial shockwave treatment report significantly improved symptoms. In terms of functional improvement, shockwave treatment marginally beats the other safe and effective approaches. This is especially true when it comes to enhancing hip mobility and functional impairment. As more and more data mounts in favour of physical therapy therapies for piriformis syndrome, these findings provide credence to the use of non-invasive techniques into conventional rehabilitation programs.

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