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Original Article

Piriformis syndrome and lumbosacral radiculopathy: An overlooked coexistence

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ABSTRACT

Objectives: This study aims to investigate the presence of piriformis syndrome (PS) in patients with clinically diagnosed lumbosacral radiculopathy (LR).

Patients and methods: In this prospective, cross-sectional study, 39 patients (14 males, 25 females; mean age: 48.2±12.2 years; range, 26 to 69 years) with evidence of L4, L5, or S1 radiculopathy and localized tenderness at the ipsilateral piriformis muscle (PM) were enrolled between February 2022 and August 2022. All patients received a 5-mL ultrasound-guided injection of 2% lidocaine into the PM. The patients whose pain resolved at least 50% from the baseline after the injection were diagnosed as having PS. Thirty-nine patients completed the one-month follow-up period.

Results: Piriformis syndrome was diagnosed in 33 (84.6%) patients with LR. The mean percentage reduction in symptoms at 1 h, one week, and one month after the injection were 66%, 57%, and 71%, respectively. Compared to baseline, all pain parameters showed statistically significant improvement at the one-month evaluation ($p<0.05$).

Conclusion: Piriformis syndrome should be regarded as a potential coexisting condition rather than an exclusion criterion in patients with LR. In patients with LR and PS, ultrasound-guided PM injections provide short-term benefits, facilitating early return to daily activities.

Keywords: Piriformis muscle syndrome, radiculopathy, sciatica, ultrasonography.

Piriformis syndrome (PS) is a neuromuscular disorder characterized by pain and tenderness in the piriformis muscle (PM) region. It may arise from intrinsic pathologies or anatomic variations of the PM, or due to extrinsic pathologies in its vicinity. Nevertheless, PS is generally thought to be myofascial in origin.[1,2] Ipsilateral leg pain may accompany buttock pain as a result of irritation or compression of the sciatic nerve by the PM. Therefore, PS is often regarded as a nondiscogenic cause of sciatica[3] and one of the musculoskeletal mimics of lumbosacral radiculopathy (LR).[4]

Lumbosacral radiculopathy is a clinical condition in which the function of one or more lumbosacral nerve roots is affected by various pathologies, most commonly by intervertebral disc herniation and degenerative spondylosis. Lumbosacral radiculopathy often presents with low back pain and radicular pain radiating to the leg or neurologic deficits in the affected nerve root distribution. Diagnosis is generally established clinically, based on compatible symptoms and physical examination findings. At present, magnetic resonance imaging (MRI) represents the principal diagnostic modality for suspected radiculopathy. Electrophysiological studies are used selectively to support differential diagnosis, particularly when discrepancies arise between clinical findings and imaging results.[5]

Piriformis syndrome is clinically suspected when there is tenderness in the PM region and pain reproduction maneuvers for PS are positive. The accepted diagnostic method is the local PM injection

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test, which is performed under imaging guidance to increase the precision of the needle placement into the PM.[6] In addition to the dramatic pain relief that confirms the PS diagnosis, PM injection test also provides some long-term therapeutic effects.[2] Imaging, and neurodiagnostic studies are usually performed to see if there is an accompanying or a causative lesion.[7]

The literature repeatedly stresses ruling out other potential causes of sciatica before a diagnosis of PS.[8,9] Currently, some authors still recognize PS as a diagnosis of exclusion.[10,11] As most of the studies about PS do not include patients with evident lumbar pathologies such as LR, PS becomes an overlooked diagnosis in these patients. As suggested by Fishman et al.,[12] we believe that the idea of "diagnosis of exclusion" is an illogical concept. Like most of the coexisting musculoskeletal disorders, it is plausible that PS and LR may coexist.[3] However, to the best of our knowledge, no research investigating the presence of PS in LR patients has been published in literature. Therefore, the primary aim of our study was to demonstrate the presence of PS in patients with LR. The secondary aim was to evaluate the short-term therapeutic effect of PM injections when there was accompanying LR.

PATIENTS AND METHODS

This prospective, cross-sectional study was conducted in the Department of Physical Medicine and Rehabilitation, İstanbul University-Cerrahpaşa, Cerrahpaşa Faculty of Medicine, between February 2022 and August 2022. Forty patients between the ages of 18 and 70, having unilateral hip and/or leg pain and tenderness at the ipsilateral PM region, with clinical findings of ipsilateral L4, L5, or S1 radiculopathy which were also confirmed by MRI were enrolled in our study. The exclusion criteria were having operation history at the lumbar and/or hip region, having received injection around the lumbar/hip or gluteal region within the last 6 months, being in gestational or lactational period, history of allergic reaction to local anesthetic (LA), and history of inflammatory or infectious or neurological disease, active psychiatric disease, uncontrolled hypertension, uncontrolled diabetes mellitus, decompensated chronic heart/liver/renal failure, or vascular/tumoral disease. Of the 40 patients who were enrolled to the study, only one patient, whose COVID-19 (coronavirus disease 2019) polymerase chain reaction test was positive three days after the diagnostic PM injection test, could not complete the follow-up period. Therefore, 39 patients (25 females, 14 males; mean age: 48.2±12.2 years; range, 26 to 69 years) who completed the follow-up period were included in final analyses. All participants provided written informed consent prior to their enrollment. The study protocol was approved by the İstanbul University-Cerrahpaşa, Cerrahpaşa Faculty of Medicine Clinical Research Ethics Committee (Date: 28.01.2022, No: 38). The study was registered with Clinical Trial Registry [NCT05392933]. The study was conducted in accordance with the principles of the Declaration of Helsinki.

All assessments were done by two physiatrists. History taking and physical examinations were performed by the first physiatrist, and sonographic evaluations were performed by the second physiatrist. A detailed history was obtained from all patients. An extensive physical examination including hip, lumbar, and sacroiliac regions was performed to rule out other sources of pain. Antalgic walking, lumbar lateral shift, gluteal atrophy, and tonic external rotation of the hip in supine position were noted during inspection. Tenderness with the palpation of the lumbar region, sacroiliac joints, greater trochanters, PM, and its radicular character on palpation of the PM were evaluated. Muscle strength, cutaneous sensation, deep tendon, and pathologic reflexes were evaluated during the neurologic examination. Pain reproduction maneuvers for PS such as FAIR (flexion, adduction, and internal rotation) test,[13] Freiberg's maneuver,[14] Beatty's maneuver,[15] Pace's maneuver,[16] active piriformis test,[17] seated piriformis test,[17] and heel contralateral knee maneuver[18] were performed. Nerve tension tests such as the straight leg raise test (SLRT) or Lasègue sign[19] and the femoral nerve stretch test[20] were also performed. Following the physical examination, any available lumbar spine or hip radiographs or MRIs were evaluated. Lumbosacral radiculopathy was diagnosed in symptomatic patients showing at least one clinical sign (muscle weakness, sensory impairment, altered deep tendon reflexes, or positive root irritation tests) and was confirmed by MRI.

All the patients with LR and a prediagnosis of PS received LA (5 mL of 2% lidocaine) injection into PM under ultrasound (US) guidance. Patients who experienced at least 50% reduction in baseline pain following injection were diagnosed with PS. All the patients were warned about actions that

could exacerbate their pain, including prolonged sitting, squatting, crossing their legs, and sitting on the ground. They were also advised to keep wearing lumbosacral orthoses and continue the previously prescribed medical treatment program.

All patients were questioned after the physical examination and at 1 h after the intervention. The primary outcome measure was at least 50% decrease of pain from the baseline 1 h after the injection. In line with our secondary objectives, pain at resting, at night, during activity, and pain in daily living activities with long duration of sitting, standing, and lying were assessed with numeric rating scale (NRS), prior to and one week and one month after the injection as secondary outcome measures. The total percentage of pain reduction during the follow-up period was also questioned.

All procedures were performed with a 1-5 MHz multifrequency convex probe (General Electric Logic P5; GE Healthcare, Little Chalfont, Buckinghamshire, UK) by a physiatrist who was experienced with interventional procedures under US guidance. For the diagnostic injection, patients suspected of having PS were placed in prone lying position on the examination table. The probe was initially placed obliquely between the S2-S4 sacral neural foramina medially and the greater trochanter laterally and then moved cranially or caudally to visualize the PM beneath the gluteus maximus and the hyperechoic sciatic nerve beneath the piriformis. A lateral-to-medial US-guided piriformis injection was then performed with a 21-23-gauge, 60-120-mm needle while continuously visualizing the sciatic nerve to prevent inadvertent blockade (Figure 1).

Sample size

In the power analysis conducted with the G*Power version 3.1 software (Heinrich-Heine Universität Düsseldorf, Düsseldorf, Germany), the minimum sample size to be included in the study was calculated as 22. The sample size calculation was based on a similar study conducted by Masala et al.[21] The effect size was 0.68, the power was 0.80, and the alpha level was 0.05. Considering possible losses, 40 cases were enrolled to the study.

Statistical analysis

All statistical analyses were performed using the NCSS (Number Cruncher Statistical System) 2007 (NCSS LLC, Kaysville, Utah, USA) program. Data were described in terms of descriptive analysis (mean, standard deviation, median, first quartile, third quartile, frequency, percentages, minimum, and maximum values) as appropriate. The Mann-Whitney U-test was conducted to compare nonnormally distributed quantitative variables between two groups and, the Kruskal-Willis test and Dunn-Bonferroni test were used to compare nonnormally distributed quantitative variables between more than two groups. The repeated-measures analysis of variance was assessed for the intragroup comparisons of the normally distributed quantitative variables, and the Bonferroni correction was conducted to evaluate paired comparisons. The Friedman test was used in intragroup comparisons of nonnormally distributed quantitative variables, and Bonferroni corrected Wilcoxon signed-rank test was used to evaluate paired comparisons. The Wilcoxon signed-rank test was conducted in intragroup comparisons of nonnormally distributed quantitative variables. Pearson's chi-square test, Fisher exact test, and Fisher-Freeman-Halton's exact test were used to analyze categorical data. Statistical significance was set at $p<0.05$.

RESULTS

Body mass index (BMI) measurements ranged from 18.10 to 41.10 kg/m^2, and the mean BMI measurement was 27.52±4.62 kg/m^2. A diagnosis of PS was made for 84.6% (n=33) of the 39 LR patients who received US-guided LA injection to the PM and whose pain subsided by at least 50% following the injection. Following the diagnostic injection test, patients were classified into two groups: LR+PS

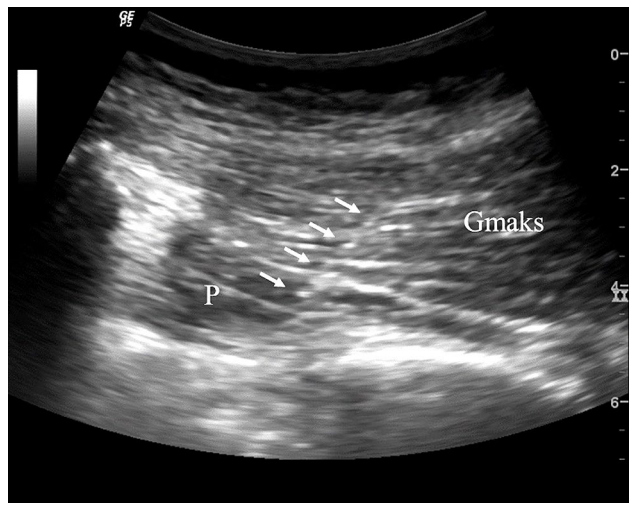

Figure 1. Piriformis muscle injection under ultrasound guidance with in-plane technique.
G: Gluteus maximus muscle; P: Piriformis muscleb.

TABLE 1
Pain characteristics and physical findings of the groups

	The LR+PS group		The LR group		
	n	%	n	%	*p*
History of trauma	6	18.2	1	16.7	0.929†
Areas of pain					
Low back pain	17	51.5	4	66.7	0.494†
Hip pain	33	100	6	100	-
Upper leg pain	28	84.8	6	100	0.307†
Lower leg pain	26	78.8	5	83.3	0.800†
Accompanying neuropathic pain	27	81.8	6	100	0.256†
Constant/occasional pain					0.060†
Constant pain	9	27.3	4	66.7	
Occasional pain	24	72.7	2	33.3	
Night pain	21	63.6	5	83.3	0.346†
Physical activities that aggravate pain					
Lying	1	3	1	16.7	0.164†
Sitting	8	24.2	2	33.3	0.639†
Rising from a sitting position	10	30.3	1	16.7	0.495†
Standing	7	21.2	0	0	0.213†
Walking	16	48.5	3	50	0.946†
Inspection					
Antalgic walking	11	33.3	3	50	0.434†
Lumbar lateral shift	3	9.1	4	66.7	0.001*†
Tonic external rotation of hip	4	12.1	1	16.7	0.759†
Palpation					
Sacroiliac joint tenderness	21	63.3	1	16.7	0.033**†
Greater trochanter tenderness	8	24.2	0	0	0.176†
Radiating pain with PM palpation	23	69.7	4	66.7	0.882†
Radiating pain with lumbar spine palpation	13	39.4	1	16.7	0.286†
Special tests					
Straight leg raise test	28	84.8	6	100	0.307†
Femoral nerve stretch test	15	45.5	2	33.3	0.582†
FABER	20	60.6	4	66.7	0.779†
FAIR	31	93.9	6	100	0.536†
Freiberg's maneuver	9	27.3	3	50	0.267†
Beatty's maneuver	19	57.6	4	66.7	0.677†
Active piriformis	21	63.6	4	66.7	0.887†
Pace's maneuver	10	30.3	2	33.3	0.882†
Seated piriformis test	13	39.4	1	16.7	0.286†
Heel contralateral knee maneuver	26	78.8	5	83.3	0.800†
Neurological examination					
Strength loss					
L2	0	0	0	0	-
L3	1	3.0	0	0	0.666†
L4	3	9.1	1	16.7	0.574†
L5	10	30.3	3	50.0	0.346†
S1	3	9.1	0	0	0.442†
Hypoesthesia					
L2	1	3.0	0	0	0.666†
L3	1	3.0	0	0	0.666†
L4	8	24.2	2	33.3	0.639†
L5	12	36.4	3	50.0	0.528†
S1	6	18.2	1	16.7	0.929†
Decreased DTRs					
Patella	4	12.1	2	33.3	0.185†
Achilles	2	6.1	1	16.7	0.370†

LR: Lumbosacral radiculopathy; PS: Piriformis syndrome; PM: Piriformis muscle; FABER: The Flexion, Abduction, and External Rotation test; FAIR: Flexion, adduction, and internal rotation; DTRs: Deep tendon reflexes; † Pearson chi-square test; * p<0.001; ** p<0.05.

(n=33) and LR (n=6). Demographic and clinical findings, as well as NRS scores during follow-up, were determined and compared in both groups.

Twenty-two (66.7%) of the patients diagnosed with LR and PS were female and 11 (33.3%) were male. Their ages ranged from 26 to 69, with a mean age of 49.42±11.81 years. Body mass index measurements varied between 18.1 and 41.1 kg/m^2, and the mean BMI value was determined as 27.53±4.71 kg/m^2. Fifty percent (n=3) of the patients diagnosed with LR without accompanying PS were female or male. Their ages ranged from 29 to 62, with a mean age of

TABLE 2
The LR characteristics of all patients included in the study

Case	Age/Sex	Symptom duration (mo)	SLRT	FNST	Weakness	Neurologic deficit		MRI	Clinical level of LR	PM injection test
						Sensory disturbance	Loss of DTRs	Nerve root compression		
1	68/F	2	+	–	+	–	+	L4, L5	> 1	+
2	29/F	1.5	+	–	–	–	–	S1	S1	–
3	63/M	18	+	–	+	+	–	L5, S1	L5	+
4	61/F	1	+	+	–	+	–	L5	L5	+
5	63/M	24	–	–	–	+	–	L3, L5	L5	+
6	54/M	5	+	–	–	–	–	S1	S1	+
7	62/M	12	–	–	–	–	+	L4	L4	+
8	46/F	12	–	+	–	–	–	L4	L4	+
9	48/M	3	+	–	–	–	–	L5	L5	+
10	50/M	2	+	–	+	–	–	S1	S1	+
11	38/M	2	+	+	–	+	–	L5	L5	+
12	37/F	7	+	–	–	–	–	L5	L5	+
13	43/F	3	–	–	+	+	–	L5	L5	+
14	64/F	18	+	–	+	+	–	L5	L5	+
15	61/F	0.5	+	–	+	+	+	L5, S1	> 1	+
16	62/F	3	+	+	–	–	+	S1	S1	–
17	48/F	0.25	+	+	–	+	–	S1	S1	+
18	42/M	3	–	+	+	–	–	L5	L5	+
19	62/M	6	+	–	–	+	+	L5	L5	+
20	46/F	12	+	+	+	+	–	L3, L4, L5, S1	> 1	+
21	48/F	12	+	+	–	–	–	L3, L5, S1	> 1	+
22	26/M	12	+	–	–	–	–	L5	L5	+
23	47/F	1	+	+	+	–	–	L5	L5	+
24	43/M	1	+	–	+	+	–	L5	L5	–
25	37/F	1.5	+	+	+	–	–	L5	L5	+
26	50/M	1	+	–	+	–	+	L5	L5	–
27	35/F	12	+	–	–	–	–	S1	S1	+
28	58/F	0.25	+	+	–	+	–	L4, L5	> 1	+
29	38/F	12	+	+	–	+	–	L5	L5	+
30	33/M	2.5	+	+	+	+	–	L5	L5	–
31	50/F	2	+	+	+	+	–	S1	S1	+
32	56/F	60	+	+	–	+	–	L4	L4	+
33	45/F	6	+	+	–	+	–	L5	L5	+
34	30/F	1	+	–	–	+	–	L5	L5	–
35	63/F	6	+	–	–	–	–	L5	L5	+
36	31/F	6	+	–	–	–	–	L5	L5	+
37	69/F	12	+	+	+	+	–	L5	L5	+
38	42/F	5	+	–	+	–	–	L5	L5	+
39	30/M	1	+	–	+	–	+	S1	S1	+

LR: Lumbosacral radiculopathy; MRI: Magnetic resonance imaging; SLRT: Straight leg raise test; FNST: Femoral nerve stretch test; DTRs: Deep tendon reflexes; PM: Piriformis muscle.

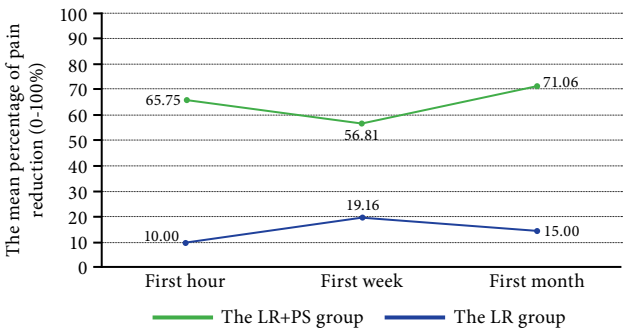

Figure 2. The mean percentage of pain reduction at 1 h, one week, and one month after the PM injection

LR: Lumbosacral radiculopathy; PS: Piriformis syndrome.

41.16±13.07 years. Body mass index measurements varied between 22 and 33 kg/m^2, and the mean BMI value was determined as 27.51±4.5 kg/m^2. When the two groups were compared according to their sex, age, and BMI measurements, no statistically significant difference was found between the groups (p>0.05).

The symptom duration ranged from 0.25 to 60 months, with a mean duration of 8.46±11.04 months, in the LR+PS group. The symptom duration ranged from 1 to 3 months, with a mean duration of 1.66±0.87 months, in the LR group. The symptom duration of the LR+PS group was significantly higher than that of the LR group (p=0.029; p<0.05). When we categorized our study group based on the duration of complaints as acute (<6 weeks), subacute (between six weeks and three months), and chronic (>3 months) among all cases, seven (63.63%) of 11 patients with acute radiculopathy, seven (77.77%) of nine patients with subacute radiculopathy, and all 19 (100%) patients with chronic radiculopathy were diagnosed with PS. No statistically significant difference was found between the groups in terms of trauma history, areas of pain, accompanying neuropathic pain, pain character, presence of night pain, physical activities that aggravate pain, special test results, and neurological examination findings (Table 1). The LR group had statistically significantly higher lumbar lateral shift (p=0.001; p<0.01), while sacroiliac joint tenderness was statistically significantly higher in the LR+PS group (p=0.033; p<0.05). Straight leg raise test and FAIR were the tests with the highest rate of positivity in both groups (Table 1). Neurologic deficiency was present in 72.7% (n=24) of the patients in the LR+PS group, and 83.3% (n=5) of the patients in the LR group. No statistically significant difference was present between the groups (p>0.05).

Data regarding the LR clinic of all cases included in the study are given in Table 2. When the physical examination findings of the cases were evaluated together with the MRI results, in the LR+PS group, 9.1% (n=3) were evaluated as having L4 radiculopathy, 57.6% (n=19) as having L5 radiculopathy, 18.2% (n=6) as having S1 radiculopathy, and 15.2% (n=5) as having multiple-level root involvement. Among the cases not diagnosed with PS, 66.7% (n=4) were evaluated as having L5 radiculopathy and 33.3% (n=2) as having S1 radiculopathy. No statistically significant differences in radiculopathy levels were observed between the groups (p>0.05).

The mean percentage of symptom reduction in both groups at 1 h, one week, and one month after the PM injection are given in Figure 2. For both groups, there were no statistically significant differences at any timepoint for mean percentage of symptom reduction from the baseline (p>0.05).

TABLE 3
Pain values measured by NRS (0-10) in the groups

	The LR+PS group (n=33)			The LR group (n=6)		
	Before the PM block	First week	First month	Before the PM block	First week	First month
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD
Rest pain	3.81±2.29	2.48±2.75*	1.39±1.93*	6.66±2.94†	6.66±2.50	5.83±3.12
Activity pain	6.33±2.72	4.24±3.10*	2.69±2.68*	9.00±0.89†	8.66±0.81	8.50±0.83
Pain disturbing sleep	4.21±3.60	2.00±3.08*	1.18±2.42*	8.50±2.73†	7.50±2.88	7.50±2.88
Standing	6.72±2.52	4.15±3.00*	2.96±3.00*	6.50±1.76	5.00±2.75	5.33±2.42
Sitting	4.72±3.30	3.24±3.21	2.00±2.62*	7.66±1.50†	6.38±2.40	6.50±3.08
Lying	5.24±3.63	3.45±350*	2.27±2.86*	7.66±1.96	6.83±1.83	7.00±1.67

NRS: Numeric rating scale; LR: Lumbosacral radiculopathy; PS: Piriformis syndrome; PM: Piriformis muscle; SD: Standard deviation; * A significant change between one week or one month after and before the PM block (p<0.05); † A significant difference between the baseline (before the block) NRS values between the groups (p<0.05).

Pain values measured by NRS at resting, at night, during activity, and in daily living activities with long duration of sitting, standing, and lying prior to and one week and one month after the injection are given in Table 3. When the groups were compared, all the baseline values of pain were statistically significantly higher in the LR group ($p<0.05$), except for the long duration of standing and lying. The group comparisons for the first week and first month evaluations revealed statistically significant differences in all pain parameters ($p<0.05$; Table 3).

For the LR+PS group, when compared to baseline NRS values, statistically significant improvements in terms of all pain parameters, except for long duration of sitting, were observed at the first week and first month evaluations ($p<0.05$). While the decrease in pain with prolonged sitting compared to the baseline was not found to be statistically significant for the first week evaluation ($p>0.05$), a statistically significant difference was found for the first month evaluation ($p<0.05$). First week and first month comparisons revealed no significant differences in reduction of pain in all evaluation parameters ($p>0.05$; Table 3).

DISCUSSION

To our knowledge, this is the first study investigating the presence of PS in patients with LR and evaluating the therapeutic effect of PM injections in accompanying LR. As a result of this study, 84.6% (n=33) of the patients with LR, were also diagnosed as having PS by giving positive response to US-guided PM block. In addition to being diagnostic for patients with LR, LA injections into the PM were also shown to contribute to the treatment with more than 70% symptom reduction in the month following the injection.

Sciatica is a general term used to describe a variety of leg or back symptoms. It is estimated that 90% of all sciatica cases are caused by a herniated disc with nerve-root compression,[22] while only about 6% of sciatica patients were found to have PS.[23] Most of the current literature consistently emphasizes that since PS is a relatively rare cause of sciatica,[24] more common pathologies of the lumbar region, such as S1 radiculopathy, sacroiliitis, facet arthropathy, and lumbar disc disease, must be ruled out before its diagnosis.[11,25] In addition to the absence of universally accepted diagnostic criteria, the use of a diagnosis-of-exclusion approach underestimates the true incidence of PS.[26] The main challenge is the lack of consensus regarding its precise definition. Piriformis syndrome is commonly described as buttock or leg pain, which is caused by compression or irritation of the sciatic nerve by the PM.[11,27] However, it remains unclear whether this is true structural or functional entrapment.[26] Broadly, PS is described as a pain syndrome involving the PM, which encompasses all pathologic lesions of PM itself, including myofascial pain, anatomical variations, and any extrinsic lesion that produces a similar clinical picture.[28] Based on our clinical experience, PS is mostly myofascial in origin. Accordingly, the diagnostic gold standard is considered to be the PM block test under imaging guidance. A symptom reduction of at least 50% following the injection is widely regarded as an important diagnostic criterion by many authors.[2,7,16,23,29] Additional imaging or electrodiagnostic are reserved for evaluating potential causal or concomitant lesions.[2,7]

There is paucity in literature regarding the presence of PS in patients with LR since majority of the PS studies use the existence of lumbar pathologies as one of their exclusion criteria. In a study by Siddiq et al.,[29] 31 patients, including those with lumbar MRI-diagnosed disc herniation, disc degeneration, and facet joint hypertrophy, were examined for the diagnosis of PS. Among the patients who were diagnosed with PS by the diagnostic block using surface anatomy landmarks, two of the patients had nerve root compression at the L4-5 levels, and three of the patients had nerve root compression at the L5-S1 levels. However, no information regarding the clinical importance of these findings were reported. Niu et al.[8] retrospectively investigated PS in 12 patients who had a history of lumbar disc herniation and unsuccessful back surgery. They retrospectively showed that after injection of LA combined with steroids into PM without imaging guidance, PS was diagnosed in 11 of the cases whose complaints decreased. According to their study's findings, patients with sciatica may be misdiagnosed and may have unsuccessful lumbar surgery if more prevalent causes such as lumbar stenosis and intervertebral disc herniation are tried to be ruled out before taking PS into consideration. Based on this, contrary to most of the literature, they recommend ruling out PS by PM injection first, as this is described as a minimally invasive technique, and then proceeding with investigation of lumbar spine pathologies.

Many studies have shown that cervical myofascial trigger points or tender spots frequently accompany

the current clinical picture in patients with cervical radiculopathy.[30,31] In a similar study investigating the presence of gluteal trigger points in patients with LR, it was found that approximately three-quarters of patients with unilateral radicular pain presented with ipsilateral gluteal trigger points.[32] However, in this study no details were provided about the level of radiculopathies and localization of the trigger points. On the other hand, there are studies indicating that myofascial pain in PM might be associated with lumbosacral spinal, pelvic, sacroiliac, or hip joint lesions.[28,33-35] According to research by Huang et al.,[33] lumbar facet lesions, primarily at the level of L5-S1, are the most common extrinsic etiology of PS. It is thought that the segmental relationship that occurs due to the anatomical convergence of sensory information in the spinal cord explains the relationship between trigger points and these pathologies.[36]

In our study, patients in the LR+PS group had a substantially longer symptom duration compared to those with LR alone. In other words, the likelihood of PS diagnosis among LR patients appeared to increase as the disease became chronic. Given the limited data on this subject, we believe that this association may be explained by the myofascial nature of the PS and the contribution of central sensitization to its pathophysiology, which could account for the increased frequency of PS in chronic LR cases.

In terms of trauma history, areas of pain, accompanying neuropathic pain, pain character, presence of night pain, physical activities that aggravate pain, inspection and palpation findings, special test results, and neurological examination findings, there was no discriminative finding for the diagnosis of PS in patients with LR, except for the presence of lumbar lateral shift and sacroiliac joint tenderness. The presence of lumbar lateral shift was significantly higher (66.7%) in patients with LR only compared to patients with a concurrent PS diagnosis (9.1%). Lumbar lateral shift is a well-known clinical finding of acute low back pain, which is frequently associated with intervertebral disc pathology and known to be associated with a poor prognosis for a conservative treatment.[37] Even though all our patients were diagnosed with LR, the higher preinjection pain levels and shorter duration of symptoms in the isolated LR group may account for the higher prevalence of lateral shift. The presence of sacroiliac joint tenderness was significantly higher (63.3%) in patients with a concurrent PS diagnosis compared to patients with LR only (16.7%). Owing to the proximity of the PM to the sacroiliac joint, sacroiliac joint tenderness is commonly detected on the affected side in patients with PS.[29] Patients with lumbar disc herniation or low back pain also have pain associated to the sacroiliac joint.[38,39] Our results show that sacroiliac joint tenderness is more common when LR and PS are present together than when LR is present alone.

Among the clinical tests that were performed, highest positivity rates were achieved with the FAIR test (93.9%) and the heel contralateral knee maneuver (78.8%) in LR patients with PS. However, these tests also demonstrated high positivity (FAIR test, 100%; heel contralateral knee maneuver, 83.3%) in LR patients without PS. Given the lack of validated sensitivity and specificity tests for PS in the literature, and the fact that these tests may also yield positive results in LR patients without PS, their role appears to be limited to raising clinical suspicion of PS and identifying possible candidates for a diagnostic PM injection.

The positivity of SLRT in PS is controversial in literature. A positive Lasègue sign was considered a significant result for PS diagnosis in earlier research.[13] Later research, however, favored PS when evaluating a negative Lasègue sign.[18] According to more recent research, SLRT is often positive in patients with PS;[17] therefore, it is not a reliable indicator.[40] In our study, SLRT was found to be positive in 87.18% of all LR cases, in 84.8% of cases with LR and PS, and in all isolated LR cases. These results indicate that SLRT can be positive in LR patients with or without PS, and its negativity does not exclude PS.

In our study, in line with the literature, when the clinical features of all cases were evaluated together with lumbar MRI results, the most affected nerve root level was L5, followed by S1, in patients with or without PS. While existing literature have described PS as a mimic of L5 radiculopathy, this study demonstrated that L5 was the most commonly affected level in PS.[4]

It was previously demonstrated that PS responded well to both LA and LA plus corticosteroid injections, and this therapeutic effect lasted at least for three months.[2] When we evaluated the results of LA injection into PM in patients with LR and PS, all the NRS scores demonstrated significant reductions at the first hour evaluations, and this

effect continued in the first month. Additionally, at the end of the first month, the mean percentage of symptoms that had decreased after the PM injection (65.75%) remained at 71.06% when the patients avoided pain exacerbating activities, used lumbosacral orthoses, and continued to take their previous nonsteroidal anti-inflammatory drug or analgesic treatment if necessary, suggesting that PM injection is a reasonable diagnostic and therapeutic strategy in cases where PS is clinically suspected, even in the presence of LR.

In addition to its diagnostic and short-term therapeutic value, US-guided PM injections enable timely initiation of targeted interventions, reducing chronicity and unnecessary spinal procedures. Incorporating postinjection rehabilitation strategies, including gentle piriformis stretching, progressive mobilization, and avoidance of prolonged sitting or leg-crossing positions, may enhance long-term outcomes and reduce recurrence. These clinical recommendations may help optimize patient recovery following the PM injection.

The follow-up and treatment of the six patients that were assessed as having isolated LR were continued after the first month of follow-up. Ultrasound-guided selective nerve root block with steroid was administered to one of these patients, while two additional patients received fluoroscopy-guided epidural transforaminal steroid injections to the affected roots. Following the injections, the symptoms in these three patients decreased by more than 50%. One of the three patient that remained symptomatic was referred to the neurosurgery department, where the patient underwent foraminotomy and partial hemilaminectomy; postoperative issues progressively subsided in this patient. After the first month of follow-up, another patient regressed without receiving any more treatment. After the first month, it was not possible to follow-up the last case. These findings suggest that the LR component was more prevalent in four cases compared to those with a PS diagnosis, which could help explain why there was no apparent reduction in symptoms following PM injection. However, further research is required to provide conclusive and understandable data on this topic.

The limitation of this study was the lack of long-term follow up. Studies with long-term follow-up to evaluate the therapeutic efficacy of PM injections in patients with LR may be planned in the future. In addition, the small number of patients in the LR group compared to the LR+PS group may be a limitation for the group comparisons. However, this imbalance also reflects the high coexistence rate of PS among patients with LR observed in our clinical population. Future studies with larger and more balanced sample sizes are warranted to further validate our findings.

In conclusion, our findings indicate that PS should be regarded as a potential coexisting condition rather than an exclusion criterion in patients with LR and that US-guided LA injections into the PM may offer short-term therapeutic benefit by facilitating early return to daily activities in patients with LR and PS.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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