BMC Surgery

SYSTEMATIC REVIEW Open Access

Piriformis syndrome: a systematic review of case reports

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Abstract

Background To study the medical history, diagnosis, management, and treatment results of piriformis syndrome (PS).

Methods Articles published between 1980 and 2024 reporting cases of PS or piriformis muscle sciatica (PMs) case/case series were included. We excluded articles that did not report anagraphic data for singular cases, diagnostic procedure, therapy, and outcome for each case. We searched PubMed database and we retrieved articles from references.

We used the Preferred Reporting Items of Systematic Reviews (PRISMA) guidelines to conduct a systematic review of the literature to identify all published cases of PS or piriformis muscle sciatica (PM). Data for all cases were collected in a database and analysed using statistical software (Statistical Package for the Social Sciences for Windows).

Results Of the 235 articles screened, 97 were included. Data from 212 patients (117 females and 95 males, mean age 43.6 ± 14.8) were collected. 38.2% of the patients in this study had a history of blunt / indirect pelvic trauma or piriform muscle (PM) stress due to vigorous physical activity/sport. 9.0% (19/212) of the patients had previously failed lumbar spine surgery.

Before treatment, the diagnosis of PS/PMs was corroborated in 29.7% of patients by intrapelvic magnetic resonance imaging (MRI); 50.5% of the patients had a PS clinical diagnosis.

Conservative treatments were effective in treating PS/PMs in 41.1% of patients; 58.9% of patients required surgical treatments. In the group of patients with PS diagnosis made without instrumental finding, the OR of surgical treatment failure occurrence was 5.3.

After treatment, the most frequent causes of PS/PMs identified by intraoperative or instrumental findings were the anatomical variant of PM or SN (12.7%) followed by pyomyositis (9.4%) and PM hypertrophy (7.5%). 47.6% of the patients had no instrumental or intraoperative findings.

Conclusions Intrapelvic MRI was the instrumental examination most frequently used to confirm the diagnosis of PS/PMs prior to treatment.

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The PS causes most frequently identified were the anatomical variant of PM or SN. In the group of patients with PS diagnosis made without instrumental finding, the OR of surgical treatment failure occurrence was 5.3.

To reduce the number of cases of persistent pain after treatment for suspected PS, it is advisable to support the clinical diagnosis through all available instrumental diagnostic procedures. However, considering all the risks that SN surgery can cause, all nonsurgical treatments should be encouraged prior to surgery.

Trial registration PROSPERO Reg. No. CRD42025641061.

Keywords Case reports, Intrapelvic sciatic nerve entrapment, Piriformis muscle sciatica, Piriformis syndrome

Introduction

Sciatica is a common symptom with a lifetime incidence ranging from 13 to 40% in the entire population; the equivalent annual incidence of sciatica episodes ranges from 1 to 5% [1].

Neuroradiological studies affirm that 85% of sciatica cases are associated with intervertebral disc disease [2]. Pathological conditions that develop in the pelvis and cause entrapment or impingement with the SN can simulate sciatica. In the pelvis, there are close spatial relationships between the SN and the piriformis muscle (PM). The growth of expansive masses inside or intrinsic alterations in PM can trigger symptoms of low back/buttock pain and leg pain, simulating vertebral sciatica. Robinson called this painful condition Piriformis syndrome in 1947, which means sciatica due to an abnormal PM [3].

PS was first added in 2019 to the 11th revision of the International Statistical Classification of Diseases and Related Health (ICD-11). Its prevalence is estimated to range between 0.3% and 6% of all cases of low back pain and/or sciatica, with an incidence in the United States of approximately 2.4 million per year [4, 5].

Instrumental exams often do not have findings that explain the pathogenesis of sciatica, and the diagnosis of PS is often based only on clinical features, excluding vertebral causes. Hopayian and Danielyan [6], in a systematic review, identified four common symptoms to consider in the diagnosis of PS: buttock pain, pain aggravated while sitting, external tenderness near the greater sciatic notch, and pain in any manoeuvre that increases PM tension and limits straight leg raising.

The difficulty in identifying the cause of PS hampers the right therapeutic choice and can lead to failure of nonsurgical or surgical treatment.

PS affects not only athletes, but also the working-age population, which means that from a social point of view, many professionals, including physiatrists, sports medicine physicians, orthopaedic surgeons, neurosurgeons, and anesthesiologists, are involved in its clinical management, from diagnosis to treatment.

Although the literature includes many case reports and series of PS cases, there is no common approach to instrumental diagnosis or treatment, and a clinical evaluation compatible with PS is often only confirmed ex adiuvantibus [7, 8].

As in medical records, case reports and small case series collect diagnostic and anamnestic details of patients, which are usually excluded in large series studies.

Case reports are written retrospectively with many details that allow the events of a disorder to be reconstructed [9].

In the challenging clinical scenario of PS, a systematic review of case reports provides a detailed picture of the diagnostic and therapeutic criteria applied in specific conditions.

The current systematic review provides an evidence-based assessment of the medical history, instrumental diagnostic approach, treatment, and outcome of published cases.

Methods

This systematic review was conducted in accordance with PRISMA and was registered in PROSPERO (CRD42025641061).

Search strategy

We performed a search on PubMed, with the following keywords: (Piriformis, syndrome) AND case report, (Piriformis, syndrome) AND series; (Pyriformis, syndrome) AND case report; (Pyriformis, syndrome) AND series; (Piriformis, sciatica) AND case report; (pyramidal, sciatic, syndrome) AND case report. The references of retrieved articles were searched for further articles. The search was carried out by 2 investigators.

Evaluation of risk of bias (quality)

Both authors separately evaluated the calibre of the included studies. If no agreement can be achieved, a third researcher was added.

Inclusion criteria

We chose to evaluate the literature of PS reports published after 1980, considering the possible availability of computed tomography (CT) examinations.

Exclusion criteria

We excluded articles that did not report anagraphic data for each patient, the diagnostic method, the treatment modality, and the outcome for each case. The following data was collected from the included studies: correspondent author specialization, publication year, age, sex, duration of symptoms, pretreatment diagnosis modalities, treatment modalities, outcome (healed-improved/nonhealed) follow-up, intraoperative findings.

The final update of the literature search was conducted in December 2024.

Statistical analysis

All data were initially entered into an Excel database (Microsoft, Redmond, Washington, United States) and the analysis was performed using the Statistical Package for the Social Sciences for Windows, version 21.0 (SPSS IBM Corp., Armonk, NY). Descriptive statistics consisted of the mean ± standard deviation [mean ± sd] for parameters with Gaussian distributions (after confirmation with histograms and the Kolmogorov–Smirnov test) and the median and range of the 1 st and 3rd interquartiles [median (1°int.q; 3°int.q)] for nonGaussian parameters.

Unidirectional ANOVA was used for comparisons between normal data and the chi-square test ((2) or Fisher's exact test (if the number of cells was < 5) for frequency data and the median test for non-normal parameters. A value of $p < 0.05$ was considered statistically significant.

Results

A total of 302 articles were identified using PubMed (284) and manual reference search (18) (Fig. 1). After excluding 67 duplicate articles, 235 were reviewed by title and abstract. 70 articles were excluded because they do not focus on PS/PMs case report/series, 9 were review articles, and 12 were articles on anatomical dissection. 144 articles were considered for eligibility. From those we excluded 6 pediatric articles (under 15 years of age), 20 articles with unclear diagnosis, 16 with no adequate patient information, 4 because there is no full text available, 1 replicated report.

Finally, we used for review 97 articles (Table 1) that reported data from 212 patients [117 females (42.2 ± 13.8 age; range (15;72) age) and 95 males (45.3 ± 15.8 age; range (15;74) age)] with a homogeneous average age (Anova; $p = 0{,}128$). The median duration of symptoms before treatment was 365 days (60;1095) and the median follow-up period was 540 days (180;1140).

Medical history

15.1% (32/212) of the patients practised sports involving the lower limbs; 7 cycling, 7 runners, 7 soccer, 4 gymnastics/fitness, 2 tennis, 2 swimming, 2 australian football/rugby, 1 basketball.

A total of 38.2% (81/212) of the patients in this study had a history of blunt trauma (e.g. falling to the bottom) or indirect pelvic trauma (e.g. hip sprain), PM stress due to vigorous physical activity (e.g. snow shoveling) or

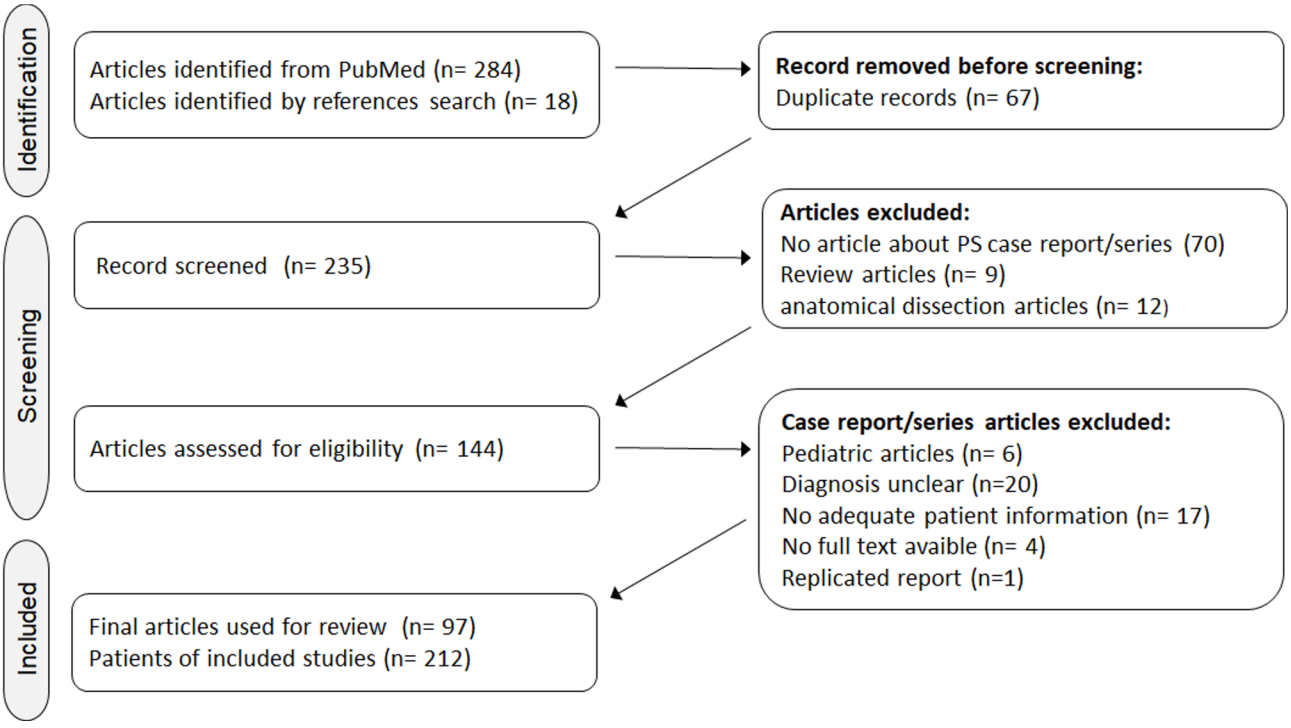

Fig. 1 The preferred reporting items of systematic reviews guidelines flow diagram

Table 1 Grouped data on the diagnosis and treatment modalities reported in the included articles

Authors, year	(F; *N*;age/M; *N*;age)*	Diag.^	Srg.°	Authors, year	(F; *N*;age/M; *N*;age)*	Diag.^	Srg.°
Adams,1980 [10]	(F:1:44,0/M:3:46,7)	Clin.	Y	Domínguez-Páez et al.,2012 [59]	(F:1:29,0/M:0:0,0)	instr.	Y
Solheim et al.,1981 [11]	(F:2:32,0/M:0:0,0)	Clin.	Y	Giebaly et al.,2012 [60]	(F:0:0,0/M:1:18,0)	Clin.	N
Augustin et al.,1984 [12]	(F:0:0,0/M:1:69,0)	instr.	Y	Kitagawa et al.,2012 [61]	(F:0:0,0/M:1:62,0)	instr.	Y
Karl et al.,1985 [13]	(F:0:0,0/M:1:41,0)	instr.	N	Wong et al.,2012 [62]	(F:1:31,0/M:0:0,0)	instr.	N
Papadopoulos,1990 [14]	(F:1:40,0/M:0:0,0)	instr.	Y	de la Peña Parra et al.,2013 [63]	(F:0:0,0/M:1:34,0)	Clin.	N
Barton,1991 [15]	(F:2:35,0/M:2:36,0)	3Clin./1instr.	N	Hamdi et al.,2013 [64]	(F:1:60,0/M:0:0,0)	instr.	N
Durrani et al.,1991 [16]	(F:0:0,0/M:1:41,0)	Clin.	N	Koda et al.,2013 [65]	(F:1:42,0/M:0:0,0)	instr.	Y
Jankiewicz et al.,1991 [17]	(F:1:27,0/M:0:0,0)	instr.	N	Polesello et al.,2013[66]	(F:1:42,0/M:0:0,0)	instr.	Y
Park et al.,1991 [18]	(F0:0,0/M:1:62,0)	instr.	Y	Sivrioglu et al.,2013 [67]	(F:1:27,0/M:0:0,0)	instr.	N
Vandertop,1991 [19]	(F:0:0,0/M:1:51,0)	Clin.	Y	Arooj et al.,2014 [68]	(F:1:35,0/M:0:0,0)	instr.	Y
Chen,1992 [20]	(F:0:0,0/M:1:42,0)	instr.	Y	Menu et al.,2014 [69]	(F:0:0,0/M:2:25,0)	Clin.	N
Hughes et al.,1992 [21]	(F:3:42,0/M:2:39,3)	instr.	Y	Ortiz Sánchez et al.,2014 [70]	(F:1:42,0/M:0:0,0)	Clin.	Y
Lam et al.,1993 [22]	(F:0:0,0/M:1:51,0)	instr.	Y	Ozisik et al.,2014 [71]	(F:8:51,1/M:2:64,5)	Clin.	N
Picco,1993 [23]	(F:1:29,0/M:0:0,0)	instr.	Y	Parlak et al.,2014 [72]	(F:0:0,0/M:1:41,0)	instr.	N
Sayson et al.,1994 [24]	(F:1:38,0/M:0:0,0)	Clin.	Y	Drampalos et al.,2015[73]	(F:1:48,0/M:0:0,0)	instr.	Y
Wun-Schen,1994 [25]	(F:1:28,0/M:0:0,0)	instr.	Y	Haghnegahdar,2015 [74]	(F:1:28,0/M:0:0,0)	instr.	Y
Kinahan et al.,1995 [26]	(F:1:22,0/M:0:0,0)	instr.	N	Kulkarni et al.,2015 [7]	(F:0:0,0/M:1:60,0)	instr.	N
Kouvalchouk et al.,1996 [27]	(F:0:0,0/M:3:37,0)	instr.	Y	Moon et al.,2015 [75]	(F:1:32,0/M:0:0,0)	instr.	Y
Beauchesne et al.,1997 [28]	(F:0:0,0/M:1:32,0)	instr.	Y	Santamato et al.,2015 [76]	(F:0:0,0/M:1:55,0)	Clin.	N
Merlo et al.,1997 [29]	(F:0:0,0/M:1:33,0)	Clin.	Y	Villano et al.,2015 [8]	(F:1:70,0/M:0:0,0)	Clin.	N
Chusid et al.,1998 [30]	(F:0:0,0/M:1:17,0)	instr.	N	Yang et al.,2015 [77]	(F:0:0,0/M:1:64,0)	instr.	N
Hanania et al.,1998 [31]	(F:2:64,5/M:4:56,3)	Clin.	N	Yıldırım et al.,2015 [78]	(F:1:51,0/M:0:0,0)	instr.	N
Benson et al.,1999 [32]	(F:9:36,2/M:5:42,0)	Clin.	Y	Zeren et al.,2015 [79]	(F:0:0,0/M:2:29,0)	instr.	Y
Ozaki et al.,1999 [33]	(F:1:22,0/M:0:0,0)	instr.	Y	Kraus et al.,2016 [80]	(F:0:0,0/M:1:68,0)	instr.	Y
Rossi et al.,2001 [34]	(F:1:30,0/M:0:0,0)	instr.	N	Vas et al.,2016 [81]	(F:0:0,0/M:1:72,0)	Clin.	N
Spinner et al.,2001 [35]	(F:1:44,0/M:0:0,0)	Clin.	Y	Han et al.,2017 [82]	(F:8:60,5/M:4:62,0)	7Clin./5instr.	Y
Foster,2002 [36]	(F:5:44,6/M:2:57,0)	instr.	Y	Phadke,2017 [83]	(F:0:0,0/M:1:21,0)	instr.	Y
Indrekvam et al.,2002 [37]	(F:15:41,9/M:4:47,0)	Clin.	Y	Wada et al.,2017 [84]	(F:0:0,0/M:1:53,0)	instr.	Y
Burkhart et al.,2003 [38]	(F:0:0,0/M:1:69,0)	instr.	N	Fusco et al.,2018 [85]	(F:2:55,0/M:1:55,0)	2Clin./1instr.	N
Jroundi et al.,2003 [39]	(F:1:30,0/M:0:0,0)	instr.	N	Ripellino et al.,2019 [86]	(F:0:0,0/M:1:35,0)	instr.	N
Nakamura et al.,2003 [40]	(F:1:40,0/M:1:23,0)	instr.	Y	Aquino-Jose et al.,2020 [87]	(F:1:36,0/M:1:29,0)	Clin.	N
Chong et al.,2004 [41]	(F:1:30,0/M:0:0,0)	instr.	N	Fahmi et al.,2020 [88]	(F:0:0,0/M:1:72,0)	Clin.	Y
Guyomarc'h et al.,2004 [42]	(F:1:38,0/M:2:26,0)	2Clin./1instr.	N	Hogan et al.,2020 [89]	(F:3:53,3/M:0:0,0)	1Clin./2instr.	Y
Lee et al.,2004 [43]	(F:0:0,0/M:1:40,0)	instr.	Y	Koh et al.,2020 [90]	(F:0:0,0/M:1:18,0)	instr.	N
Vallejo et al.,2004 [44]	(F:1:29,0/M:0:0,0)	instr.	N	Leong et al.,2020 [91]	(F:0:0,0/M:1:24,0)	instr.	N
Hettler et al.,2006 [45]	(F:1:44,0/M:0:0,0)	instr.	Y	Ou Yang et al.,2020 [92]	(F:1:16,0/M:0:0,0)	instr.	Y
Kosukegawa et al.,2006 [46]	(F:0:0,0(M:1:57,0)	instr.	Y	Akbas et al.,2021 [93]	(F:1:18,0/M:0:0,0)	instr.	Y
Turtas et al.,2006 [47]	(F:0:0,0/M:1:60,0)	instr.	Y	Kale et al.,2021 [94]	(F:1:42,0/M:0:0,0)	instr.	Y
Colmegna et al.,2007 [48]	(F:1:18,0/M:0:0,0)	instr.	N	Lodin et al.,2021 [95]	(F:0:0,0/M:1:55,0)	instr.	Y
Kabataş et al.,2008 [49]	(F:1:36,0/M:0:0,0)	Clin.	N	Salehi et al.,2021[96]	(F:0:0,0/M:1:43,0)	instr.	N
Kobbe et al.,2008 [50]	(F:0:0,0/M:2:45,0)	instr.	Y	Shanmuga Jayanthan et al.,2021 [97]	(F:0:0,0/M:1:41,0)	instr.	Y
Wong et al.,2008 [51]	(F:3:58,0/M:0:0,0)	instr.	N	Chua et al.,2022 [98]	(F:1:63,0/M:0:0,0)	instr.	N
Dere et al.,2009 [52]	(F:2:27,5/M:0:0,0)	instr.	N	Güleç et al.,2022 [99]	(F:1:30,0/M:3:30,6)	instr.	N
Niu et al. 2009 [53]	F:6:43,0/M:6:46,6)	Clin.	N	Kaga et al.,2022 [100]	(F:0:0,0/M:1:71,0)	Clin.	N
Yoshimoto et al.,2009 [54]	(F:2:55,0/M:1:59,0)	2Clin./1instr.	2Y/1 N	Kwon et al.,2022 [101]	(F:0:0,0/M:1:40,0)	instr.	N
Hwang et al.,2010 [55]	(F:1:42,0/M:0:0,0)	instr.	Y	Ward et al.,2022 [102]	(F:0:0,0/M:1:14,0)	instr.	Y
Jawish et al.,2010 [56]	(F:4:28,5/M:5:41,8)	1Clin./8instr.	Y	Gebregiorigis et al.,2024 [103]	(F:0:0,0/M:1:14,0)	instr.	Y
Jeon et al.,2010 [57]	(F:1:50,0/M:0:0,0)	instr.	N	Qiu et al.,2024 [104]	(F:0:0,0/M:1:14,0)	instr.	Y
Ye et al.,2010 [58]	(F.0:0,0/M:1:74,0)	instr.	N				

(*) F;N; age/M;N; age= Females; Number; age/Males; Number; age

(^) *Diag.* Diagnosis, *Clin.* Clinical Diagnosis, *instr.* Diagnosis corroborated by instrumental examination or PM injection test

(°) Srg.= Surgery; Yes= Y; No= *N*

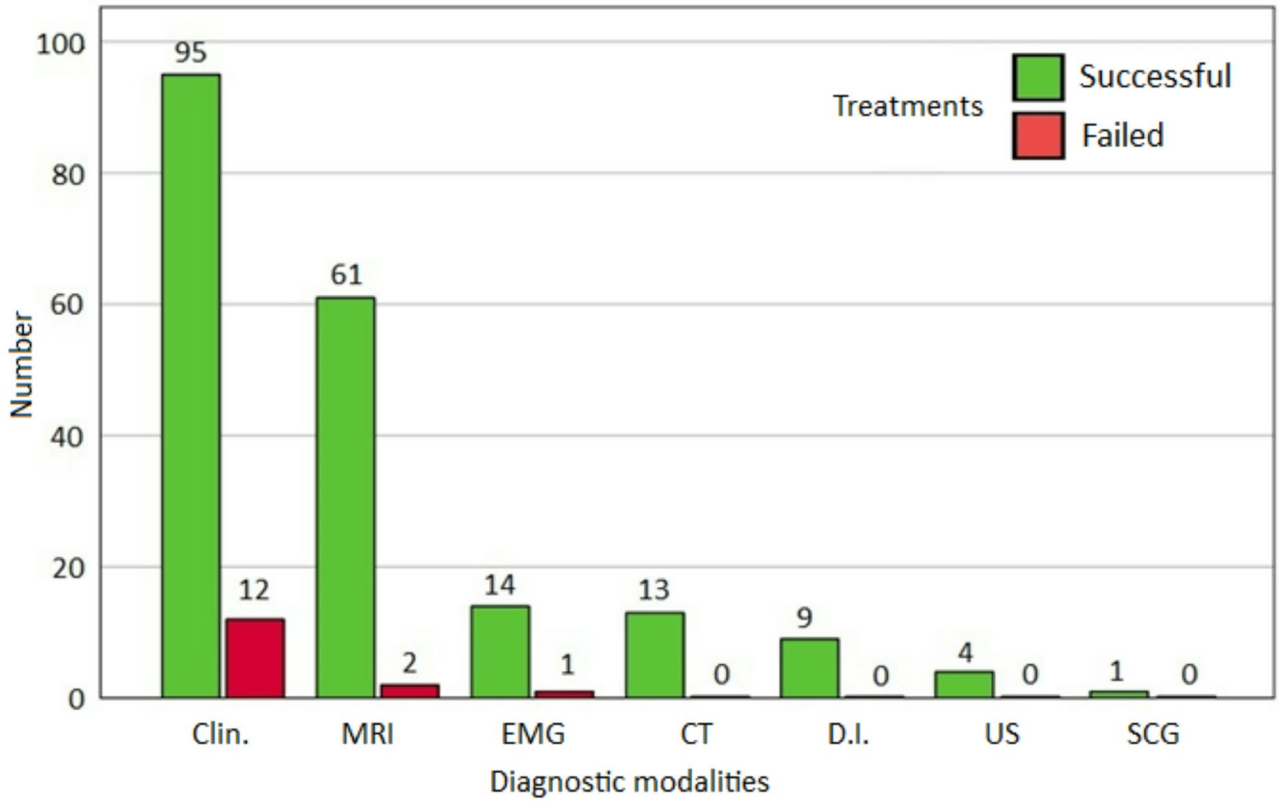

Fig. 2 Number of patients who had successful/failed treatments in relation to the diagnostic modalities

sport practice. A total of 4.7% (10/212) of the patients reported factors associated with pyomyositis/hematoma: 4 patients with gynecological surgical treatment/pathology, such as partum epidural analgesia and abort, 2 patients with anticoagulant treatment, 2 patients with postinjection gluteal abscess, 1 patient with recent lung infection, and 1 patient with hydronephrosis.

In 57.1% (121/212) of the patients, the authors did not report any factors associated with PS.

Diagnosis

Before treatment, our review revealed that 49.5% (105/212) of the patients had PS/PMs diagnosis corroborated by an instrumental exam or PM diagnostic injections (D.I.). The diagnosis of PS/PMs was corroborated in detail as follows: 29.7% (63/212) by intrapelvic MRI or magnetic resonance neurography, 2 of whom did not heal; 7.1% (15/212) only by electromyography (EMG), 6 of them had some improvement after PM injection before surgery, 1 did not heal. 6.1% (13/212) by CT, 4.2% (9/212) only by PM diagnostic injections (D.I.), 1.9% (4/212) by diagnostic ultrasound (US), and 0.5% (1/212) by bone scintigraphy (SCG), all patients healed. A total of 50.5% (107/212) of the patients were diagnosed with PS by the symptoms, medical history, and P.E. (clinical diagnosis), 12 of whom did not heal. The graph in Fig. 2 shows the number of patients who had successful/failed treatment compared to the diagnostic modalities.

After treatment, according to the author's conclusions, by instrumental examination or intraoperative finding, the etiological factors of PS/PMs were as follows (Table 2): 12.7% (27/212) PM or SN anatomical variant, 9.4% (20/212) PM pyomyositis, 7.5% (16/212) PM hypertrophy, 5.7% (12/212) fibrous adherent scar tissue around the SN, 3.8% (8/212) vascular anomalies (e.g. plexus of veins surrounding the SN, loop in a collateral of the inferior gluteal artery compressing the SN, pseudoaneurysm, aneurysm), 1,9% (4/212) PM hematoma, 0.9% (2/212) lipoma 0.9% (2/212) endometriosis, 0.5% (1/212) PM atrophy, PM calcification, 0.5% (1/212) cyst impinging SN, 0.5% (1/212) PM lymphoma 0.5% (1/212), PM myositis ossificans 0.5% (1/212). Furthermore, in other patients, the authors reported 3.8% (8/212) PM/SN MRI hyperintensity, 1.4% (3/212) EMG findings of SN H reflex delay/absence, 0.9% (2/212) PM/SN US hyperechoic signal, 0.5% (1/212) SCG findings of abnormal PM uptake. 47.6% (101/212) of the patients had no instrumental or intraoperative findings.

Treatment modalities

40.1% (85/212) of the patients received nonsurgical treatment: 25.0% (53/212) received local injection with

Table 2 Treatment modalities and definitive instrumental and intraoperative findings

Treatment modalities	***n***	**%**
Piriformis tendon release	104	49.1
SN neurolysis	8	3.8
Abscess drainage	7	3.3
Masses resection	5	2.4
Aneurysm resection	2	0.9
Pseudoaneurysm decompression	1	0.5
Anesthetic/corticosteroids injection	53	25.0
Antibiotic therapy	12	5.7
Exercise programs/physiotherapy	10	4.7
Botulinum injection	4	1.9
Dry nilling	3	1.4
Chemotherapy	1	0.5
Shockwave therapy	1	0.5
Suspension of drug	1	0.5
Total	212	100.0
Definitive instrumental/intraoperative findings	***n***	**%**
PM/SN anatomical variant	27	12.7
PM pyomyositis	20	9.4
PM hypertrophy	16	7.5
Scar tissue	12	5.7
Vascular anomalies	8	3.8
PM hematoma	4	1.9
PM lipoma	2	0.9
PM endometriosis	2	0.9
PM atrophy	1	0.5
PM calcification	1	0.5
Cyst	1	0.5
PM lymphoma	1	0.5
PM myositis ossificans	1	0.5
PM/SN hyperintensity (MRI)	8	3.8
SN H reflex delay/absence (EMG)	3	1.4
PM/SN hyperechoic signal (US)	2	0.9
PM abnormal uptake (SCG)	1	0.5
Diffusion MRI tractography SN/PM findings	1	0.5
No instrumental/intraoperative findings	101	47.6
Total	212	100.0

anesthetic and/or corticosteroids, 5.7% (12/212) received antibiotic therapy, 4.7% (10/212) received specific exercise programs and/or physiotherapy, 1.9% (4/212) received botulinum injection, 1.4% (3/212) received dry needling, 0.5% (1/212) received chemotherapy, 0.5% (1/212) received shockwave therapy, 0.5% (1/212) received drug suspension (atorvastatin).

Most of the patients (59.9% (127/212)) had surgical treatment. The surgical procedures used were as follows: 49.1% (104/212) release of the piriformis tendon (in the presence/absence of adhesions, vascular anomalies, PM pyomyositis, anatomical variant, hematoma, lipoma), 3.8% (8/212) neurolysis of the SN, 3.3% (7/212) surgical drainage of abscesses, 2.4% (5/212) masses resection (hematoma, lipoma, cyst, endometriosis), 0.9% (2/212) aneurysm resection and 0.5% (1/212) pseudoaneurysm decompression (Table 2).

Outcome

In total, 197/212 (92.9%) patients healed/improved after therapy. In detail: 116/197 (58.9%) patients healed after surgery while 81/197 (41.1%) patients healed after non-surgical therapy; oppositely, 15/212 (7.1%) patients had no pain relief (11/15 after surgery and 4/15 after nonsurgical treatment).

In 127 of 212 (59.9%) surgically treated patients, 69 of 127 (54.3%) had a diagnosis of PS corroborated by an instrumental exam/D.I., while 58 of 127 (45.7%) patients had a clinical diagnosis.

In the 69/127 group, only 2 (2.9%) patients did not heal after surgery, while in the 58/127 group, 9 (15.5%) patients did not heal: In the last group the OR of surgical treatment failure occurrence was (15.5%/2.9%) = 5.3; 95% Confidence Interval (CI) (5,0;5,8).

In 85 of 212 (40.1%) nonsurgically treated patients, 36 of 85 (42.4%) had a diagnosis of PS corroborated by instrumental examination, while 49 of 85 (57.6%) patients had a clinical diagnosis.

In the 36/85 group only 1 patient (2.8%) did not heal after conservative treatment, while in the 49/85 group 3 (6.1%) patients did not heal after treatment: the odds ratio (OR) was (6.1%/2.8%) = 2.2; 95% CI (2,1;2,4).

We also found that 9.0% (19/212) of the patients had previously failed lumbar spine surgery (14 females; 5 males): 17 of them had pain relief after PS therapy.

Discussion

Our review specifically addressed the presumed or confirmed cases of SN compression involving the PM: We excluded other intrapelvic impingements of the SN [105, 106], which deserve a differential diagnosis.

Consistent with other studies [107–109] the patients included in this review were mainly women (female to male ratio of 1.2:1), with an average age of 43.6 years, in the age range of the highest risk of PS (30–50 years).

The medical history of PS patients often shows that an event is correlated with muscular damage. Direct or indirect pelvic trauma or strenuous physical exercise in PM can be associated with muscular damage. The resulting soft tissue inflammatory changes and edema can predispose individuals to SN impingement or scarring surrounding the SN, thus causing SN entrapment [110]. In our review, 38.2% of patients reported direct or indirect pelvic trauma or PM stress due to vigorous physical activity/sport practice.

In general, the authors considered the positivity of the following tests and signs a P.E. suggestive of PS [6, 36, 64]:

the piriformis sign (a persistent external rotation of the extended limb in the supine patient); the Freiberg test (sciatica appears with forceful internal rotation of the hip with the patient supine); the Beatty test (sciatica appears when the patient maintains the hip flexed in abduction against gravity while lying on the non -affected side); the Pace test (buttock pain increases by applying resistance to the abduction of the hip holding the patient's knee in the sitting position); the FAIR position (pain is exacerbated with the hip flexed, adducted, and internally rotated).

PM pyomyositis in its early appearance causes sciatica and represents a fearful cause of PS because delay in diagnosis can be life-threatening [50]. The clinical signs of PM pyomyositis are typically mild buttock pain and sciatica for a few days, followed by an increase in body temperature [89]. Its pathogenesis may be related to muscle damage with concomitant asymptomatic bacteremia [38, 91]. Specifically, Staphylococcus is the microorganism most often isolated from patients. In our review, blood cultures also yielded P. mirabilis Group B Streptococcus and Salmonella typhi. In three cases, the infectious agent has not been identified [26, 40, 64].

For all cases of PM pyomyositis reported here (20 cases), MRI or CT scans allowed rapid diagnosis and therapy. In 4 cases, pyomyositis occurred in patients who practice sports [30, 38, 59, 91].

MRI scan of the pelvis is the most commonly adopted test to corroborate the diagnosis of PS/PMs (29.7%).

A pelvic MRI neurogram with complex oblique planes may reveal anatomical variants of SN [79].

The diffusion MR tractography technique allows the orientation of the nerve fibers to be followed for tracing specific neural pathways and visualizing the condition of the nerve fibers [84].

A standard MRI scan can detect localized or diffuse changes in the PM, a mass impinging the SN, but sometimes it can identify only an increase in PM volume [17].

In contrast to the theory of an association between PM hypertrophy and PS, some authors believe that PM asymmetry is common in asymptomatic subjects [32].

In this review, PS associated with PM hypertrophy was treated with good results in 11 out of 13 patients.

In some patients, diagnostic imaging is unblemished, but EMG can reveal findings suggesting sciatic nerve entrapment in PM [21].

Ozisik et al. [70] reported that intrapelvic sciatic nerve impingement should delay the H reflex. In PS patients, EMG under standard conditions may not reveal pathological findings. PM stimulation may induce changes in EMG: Zeren et al. [78], in two male soccer players, reported pathological changes in a previously normal EMG after a short run or by placing the affected lower limb in internal rotation and adduction (pain position).

Nakamura et al. [40] detect the potential of the cauda equina using an epidural electrode. The potentials were recorded first with the patient's leg extended and then with the patient's hip flexed and rotated internally: In this posture, on the affected side, the recorded potentials exhibited polyphasic deformity.

After a negative or nonspecific instrumental diagnostic assessment, some authors perform a D.I. and make a diagnosis of PS based on the temporary disappearance of symptoms [36, 82].

Local injection of drugs to treat PS could have adverse effects, such as anesthetic intoxication, infection, and muscle atrophy after steroid injection, and weakness and pain after botulinum toxin injection [100]. In this review, no adverse effects were reported.

The most frequent diagnosis of PS/PMS has been identified in a PM or SN anatomical variant (12.3%) followed by PM pyomyositis (6.1%), PM hypertrophy (5.7%). In some cases, even intraoperative inspection could not identify any cause of SN impingement [56].

In one patient, an MRI scan revealed PS caused by statin-induced piriformis myopathy: patient recovery occurred after therapy suspension [64]. He previously received an ineffective local corticosteroids injection.

59.9% of patients underwent surgery; complications of SN entrapment surgery include hematoma formation, infections, permanent paresthesia, hyperesthesia, superficial surgical site infection, deep wound infection, failure to resolve pain or worsened pain [111–113]. Justice et al. [111] reported two cases of permanent impairment of muscle function below the knee after PM release surgery (paper not included in our database). The injury mechanism hypothesized for this serious complication was blade retraction, as occurs in prosthetic hip surgery. In our review, in three patients, recurrence occurred a few months after PM release and these patients underwent revision surgery [50, 74].

Surgery did not relieve pain in 11 patients [35, 37, 56, 74, 82]. Nine of them had no instrumental diagnosis nor a positive D.I. was reported: in the group of patients with PS clinical diagnosis, the OR of surgical failure occurrence was 5.3.

To avoid unnecessary spine surgery, Niu et al. [53] suggest excluding PS before diagnosing lumbar radiculopathy: In this review, 9% (19/212) of the patients had failed spine surgery and 89.5% of them (17) had pain relief after PS treatment.

Study limitations

Each physician or surgeon adopted their own diagnostic protocol. In cases of suspected PS, priority was given to different diagnostic modalities — for instance, DI was sometimes performed before EMG or MRI, and vice versa. This variability made it difficult to compare the

effectiveness of individual diagnostic tools across similar cases.

The limitations of this review also include case report admission and selection bias: case reports are usually selected for publication because outliers are unique. Furthermore, the natural tendency of authors and journals to propose and publish positive cases could influence the overall outcome, increasing the number of cases with good results [114, 115].

Unfortunately, it was not possible to describe the anthropometric data (weight, height) of the patients due to the lack of such information in the articles.

Conclusions

Intrapelvic MRI was the instrumental examination most frequently used to confirm the diagnosis of PS/PMs prior to treatment. After treatment, the causes most frequently identified by instrumental exam or intraoperative finding were the anatomical variant of PM or SN, PM pyomyositis, and PM hypertrophy.

In the group of patients with PS clinical diagnosis the OR of surgical treatment failure occurrence was 5.3. Given the risks that sciatic nerve surgery in this region may entail, underestimated by this review, in suspected PS, it is needed to carry out all available instrumental diagnostic procedures to reduce surgical failures and complications.

Abbreviations

SCG	Bone scintigraphy
CT	Computed tomography
CI	Confidence interval
Clin.	Clinical diagnosis
D.I.	Diagnostic injections
Diag.	Diagnosis
EMG	Electromyography
instr.	Diagnosis corroborated by instrumental examination or PM injection test
MRI	Magnetic resonance imaging
OR	Odds ratio
PM	Piriformis muscle
PMs	Piriformis muscle sciatica
PS	Piriformis syndrome
P.E.	Physical examination
SN	Sciatic nerve
Srg.	Surgery
US	Ultrasound

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12893-025-03202-2.

Supplementary Material 1.

Acknowledgements

Not applicable.

Authors contributions

Author' contributions Conceptualization: GM, GS, RS.Methodology: GM, GS, RS.Writing – original draft: GM, MA.Writing – review and editing: GS, MA, EC.Statistical analysis: RS.Bibliographic research: GM, EC.Supervision and correspondence: GM.All authors critically revised the manuscript and approved the final version.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data availability

Data are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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Received: 12 May 2025 / Accepted: 2 September 2025
Published online: 09 October 2025

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