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Piriformis muscle syndrome: MR imaging findings and treatment outcome in 23 patients

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ABSTRACT

Purpose: To increase the clinical awareness of piriformis muscle syndrome (PMs) by reporting the magnetic resonance (MR) imaging findings and therapeutic outcome in a series of 23 patients with clinically suspected syndrome.

Material and Methods: Within a four-year period, 23 pelvic magnetic resonance (MR) imaging studies from 23 patients with clinically suspected PMs were retrospectively reviewed. Patients were recruited in four health care centers in three countries. Piriformis muscle (PM) dimensions/signal intensity and the presence of sciatic neuritis were assessed. The piriformis region was examined for the presence of PMs related causes. The syndrome was categorised into primary and secondary, according to a widely used classification system. Treatment decisions were recorded and outcome was categorised as response (R) or no response (NR).

Results: Fourteen patients (61%) showed abnormal signal within the PM, 11 (48%) enlargement of the muscle and 8 (35%) sciatic neuritis. Ten patients were classified in the primary causes and 13 into secondary. Space occupying lesions comprised the leading cause of PMs and imaging played a crucial role both in diagnosis and in treatment planning. Treatment decisions proved effective in 8/8 patients with primary and in 9/13 patients with secondary PMs.

Conclusions: In suspected PMs, MR imaging may depict a spectrum of findings including PM signal alterations/enlargement and sciatic neuritis, related to either primary or secondary causes. Space occupying lesions represented the leading cause of PMs.

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KEY WORDS

piriformis muscle syndrome; MR imaging/diagnosis; sciatica/sciatic nerve; therapy

1. Introduction

Piriformis muscle syndrome (PMs) represents a controversial clinical entity which is characterised by irritation of the sciatic nerve (SN) in the piriformis region, along its way through the greater sciatic foramen [1, 2]. Numerous definitions have been proposed and no consensus exists on the use of this term, causing confusion regarding the description of a specific clinical scenario.

In clinical practice, causes of extra-spinal SN entrapment are often overlooked and underdiagnosed as they are usually manifested with signs and symptoms resembling lumbar spinal pathology [2,3]. The lack of agreement upon clinical diagnostic criteria regarding the isolation of extra-spinal causes of SN compression combined with the unavailability of an established imaging algorithm potentially contribute to delayed diagnosis of these conditions.

According to its aetiology, PMs can be divided into two types. Primary syndrome describes all intrinsic piriformis muscle (PM) pathologies such as anatomical variations of the PM/SN relationship or PM myositis, whereas secondary aetiologies refer to all other conditions related to sciatic neuropathy at the level of the greater sciatic foramen [4-6]. Research has mainly focused on primary PMs, with secondary aetiologies being sporadically reported on case reports [7-12].

Herein, we aimed to increase the clinical awareness of a controversial entity by reporting the cross sectional imaging findings and therapeutic outcome in a series of patients with clinically suspected PMs.

2. Material and Methods

Patients

Within a four-year period, 23 pelvic MR imaging studies from 23 patients who were referred for radiological evaluation of clinically suspected PMs were retrospectively reviewed. Patients were recruited in four health care centers in 3 countries (Greece, United Kingdom, Cyprus). Inclusion criteria included: (i) buttock or posterior thigh pain; (ii) tenderness on palpation over the piriformis region and (iii) a positive passive and a positive active piriformis test. Exclusion criteria included: (i) unavailability of a recent (up to 6 weeks before referral) MR imaging study of the lumbar spine showing no or irrelevant to symptomatology findings and (ii) any previous intervention at the piriformis region. Demographic information including age, sex and clinical symptoms/signs were collected using the electronic medical database. All treatment decisions and outcome were recorded and response to treatment was classified as response (R) or no response (NR). Ethical committee approval according to Helsinki's declaration was obtained together with the written informed consent of all patients prior to each imaging investigation.

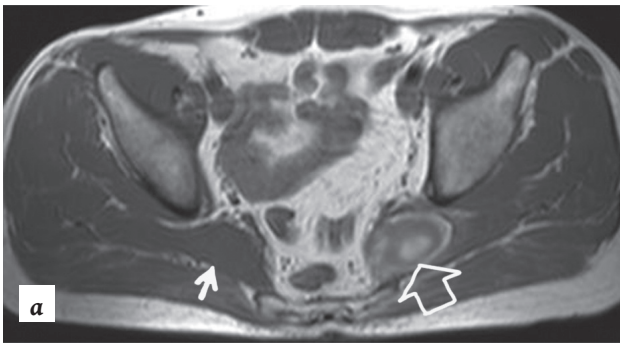
Imaging technique

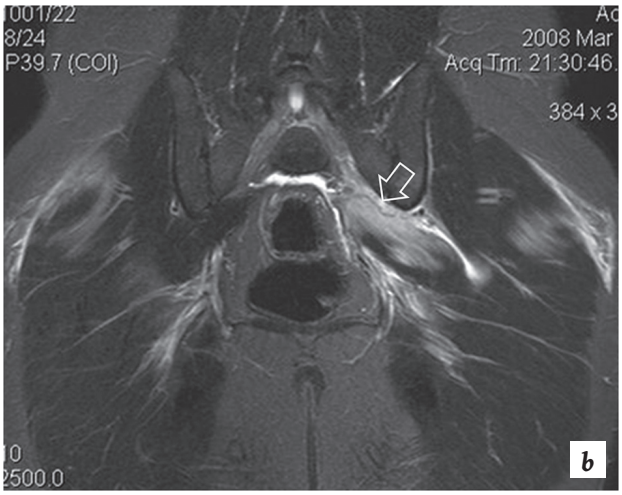
All MR examinations were performed on 1.5 and 3 Tesla scanners (Siemens Vision 1.5, Siemens Avanto 1.5 and Philips Achieva 3.0) according to a tailored pelvic MR imaging protocol using a phased array pelvic coil. Patients were scanned in the supine position. The MR imaging protocol consisted of coronal/oblique coronal/axial T1-weighted (W) turbo spin-echo (TSE) images (slice thickness: 4 mm; matrix: 512×256; FOV: 37.5 cm), coronal T1-W turbo inversion recovery (STIR) images (slice thickness: 4 mm; matrix: 320×288; FOV: 40 cm), axial/oblique coronal fat suppressed (FS) T2-W TSE images (slice thickness: 4 mm; matrix: 280×320; FOV: 40 cm) and contrast-enhanced FS T1-W TSE images in axial, coronal and sagittal planes, in selective cases, based on the findings on conventional sequences. The oblique coronal plane was acquired along the long axis of the sacrum, planned on the mid-sagittal image. Fat suppression was achieved with spectral presaturation or with STIR.

Imaging Analysis

All MR imaging studies were reviewed by two musculoskeletal and two senior radiologists with experience ranging from 10 to 33 years in musculoskeletal imaging.

In all patients, PM dimensions, signal intensity as well as enhancement pattern were evaluated. The presence of





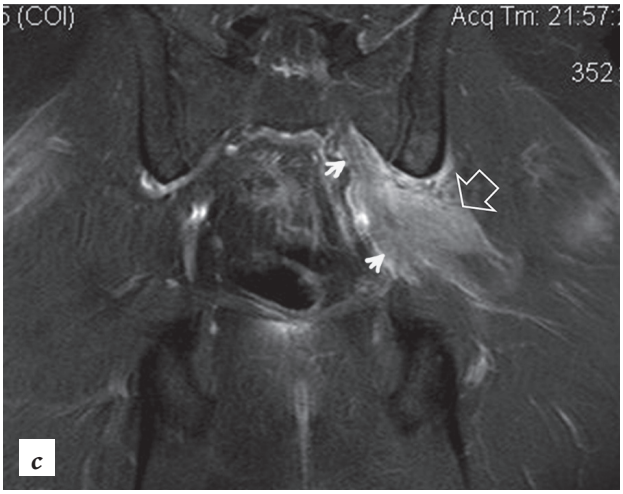


Fig. 1. *Spectrum of MR imaging findings in primary piriformis muscle syndrome.* ***a.*** *Primary syndrome in 44-year-old male patient under anticoagulant therapy for atrial fibrillation. A spontaneous haematoma in the left piriformis muscle is shown on the T1-W MR sequence (open arrow). The normal right piriformis muscle is shown for comparison (arrowhead).* ***b.*** *A 31-year-old male patient with viral myositis of the piriformis muscle: coronal STIR MR image shows enlargement and oedema of the left piriformis muscle (arrow).* ***c.*** *Infectious myositis in a 65-year-old female patient. Coronal fat suppressed contrast enhanced T1-W MR image shows enhancement of the oedematous muscle (open arrow) and enhancement of the sciatic nerve (arrowheads)*

sciatic neuritis was assessed, by means of neural enlargement, loss of the normal fascicular appearance and perineural/endoneural hyperintensity on fluid sensitive sequences and enhancement after contrast administration [13, 14]. PM asymmetry of more than 8 mm was considered abnormal [14, 15]. The piriformis region was evaluated for the presence of any causes of neural entrapment, including fibrous bands.

The syndrome was categorised into primary or secondary, according to widely used classification system [4-6]. Primary causes included all intrinsic PM pathology, such as PM hypertrophy, PM myositis and post-traumatic PM lesions. Secondary causes included all other conditions related to sciatic neuropathy at the level of greater sciatic foramen, such as space-occupying lesions.

Statistical analysis

For the statistical analysis MEDCALC version 9.6 was used. Standard descriptive results were expressed as mean and standard deviation (SD).

3. Results

Twenty-three patients (14 males, 9 females; age range: 15-73 years; mean: 52.2 years) were included in the study. Unilateral symptoms were found in 16 patients (69.6%: 9 left sided, 7 right sided) and bilateral symptoms in 7 (30.4%). Fourteen patients (60.9%) showed abnormal signal within the piriformis muscle, 11 (47.8%) enlargement of the muscle and 8 (34.8%) sciatic neuritis (**Fig. 1**). The aetiologies and imaging findings in patients with PMs, are demonstrated on **Table 1**.

PMs was classified as primary in 10 patients (43.5%) (**Fig. 1**), 7 males and 3 female (age range: 29-73 years), whereas secondary causes were disclosed in the remaining 13 patients (56.5%) (**Fig. 2-4**), 7 male and 6 females (age range: 15-72 years). Space occupying lesions com-

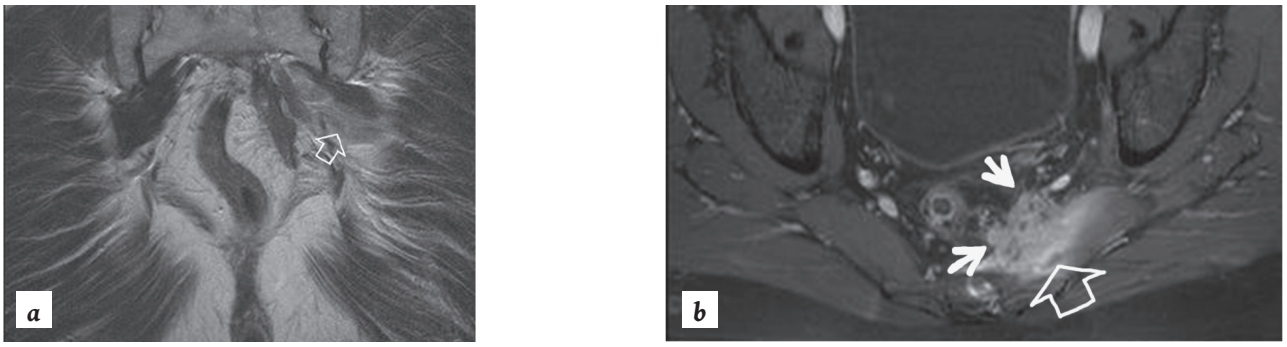


Fig. 2. *A 66-year-old male patient with known rectal carcinoma and recurrent pain on the left with a clinical diagnosis of piriformis muscle syndrome. Coronal T2-W (a) and axial fat suppressed contrast enhanced T1-W (b) MR images, show the abnormal signal and enhancement of the piriformis muscle (open arrows) and the metastatic deposits anterior to the muscle (arrowheads)*

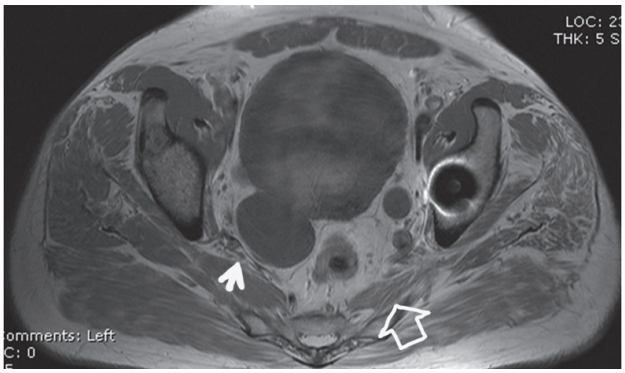


Fig. 3. *A 65-year-old male patient with long standing intermittent right piriformis muslce syndrome. Axial PD-W MR image shows a large bladder diverticulum in close proximity with the right sciatic nerve (arrowhead). Muscular atrophy on the left hemipelvis, including the piriformis muscle (open arrow), is related to long standing left hip joint osteoarthritis which was treated with total hip replacement*

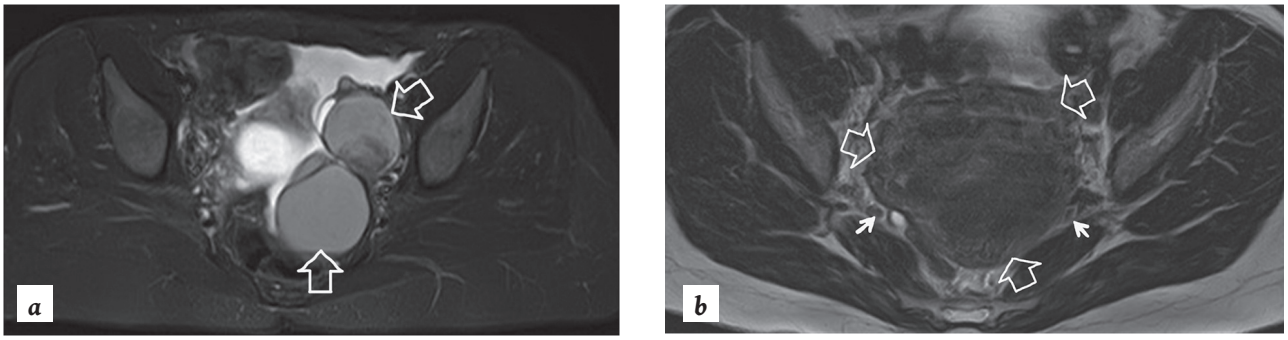


Fig. 4. *Secondary piriformis muscle syndrome due to gynaecological pathologies. A. Piriformis syndrome since 5 months, in a 31-year-old female patient with a history of surgically removed endometriomas. Axial T2-W MR image shows the large endometriomas (open arrows) demonstrating the "shading effect" on T2-W images. These proved to irritate the sciatic nerve on the left as shown with complete resolution of symptoms after surgical removal. B. A 46-year-old female patient with piriformis syndrome on the left. Axial T2-W MR image shows an enlarged uterus with adenomyosis and leiomyomas (open arrows) compressing the left sciatic nerve (arrowhead). The normal right sciatic nerve is shown for comparison (thin arrow)*

prised the leading cause of PMs. The categorisation of the causes of PMs into primary or secondary is shown in **Table 1**.

Treatment decisions and outcome were available for 21 patients (91.3%), 8 with primary and 13 with secondary PMs. Treatment options included conservative treatment, surgical treatment, administration of corticosteroids and chemotherapy with or without radiotherapy. One patient refused any treatment. Treatment outcome according to therapeutic decision for patients with primary and secondary PMs is illustrated in **Table 2**.

Table 1. Imaging findings and related aetiologies in patients with piriformis muscle syndrome (PMs). PM, piriformis muscle; M, male; F, female; SI, signal intensity; THR, total hip replacement; SN, sciatic nerve

No	Sex	Age	Final Diagnosis	Sciatic Neuritis	PM Enlargement	PM abnormal SI
Primary PMs						
1	M	31	PM myositis (post viral)	✓	✓	✓
2	M	56	PM myositis (post-radiation)			✓
3	F	65	PM pyomyositis (Staphylococcus Aureus)		✓	✓
4	M	72	PM hypertrophy	✓	✓	
5	M	44	Spontaneous PM hematoma		✓	✓
6	M	29	PM myositis		✓	✓
7	M	67	PM myositis (statin administration)		✓	✓
8	F	49	PM myositis (post-radiation)	✓	✓	✓
9	F	73	PM myosistis (post-radiation)	✓	✓	✓
10	M	61	PM myositis (colchicine administration)		✓	✓
Secondary PMs						
1	F	70	Non Hodgkin lymphoma		✓	✓
2	F	31	Endometriomas	✓		
3	F	46	Uterine leiomyomas and adenomyosis			
4	F	15	Hematocolpos			
5	F	43	Duplication cyst of rectum			
6	M	65	THR, contralateral PM enlargement, SN entrapped between PM and urinary bladder diverticulum	✓	✓	
7	M	47	Non Hodgkin Lymphoma	✓		
8	F	35	Metastatic breast carcinoma			✓
9	M	66	Recurrent rectal carcinoma			✓
10	M	61	Metastatic lung carcinoma	✓		✓
11	M	72	Sciatic nerve schwanomma			
12	M	39	Chondrosarcoma			
13	M	64	Multiple myeloma			✓

Table 2. Treatment decisions and outcome. The number of patients and categorisation according to outcome for each treatment decision is depicted. PMs, piriformis muscle syndrome; R, response; NR, no response

		Treatment Outcome	
		R	NR
Primary PMs	Corticosteroids	3	
	Conservative	5	
Secondary PMs	Surgical treatment	6	1
	Chemotherapy/Radiotherapy	3	3

4. Discussion

PMs represents a clinical entity which has been ascribed to stress on the SN by the PM, causing sciatica [2]. Numerous definitions have been proposed for SN compression at the level of the greater sciatic foramen causing controversy regarding the description of a specific clinical condition. Despite the evolution of modern advances in imaging techniques, PMs remains a controversial entity and a diagnosis of exclusion.

Clinical assessment of PMs is challenging as it may show overlapping symptoms with, admittedly more commonly encountered, lumbar or hip pathologies and no diagnostic tests have proven to be definitive [3]. The presence of a positive active piriformis test combined with a positive seated piriformis stretch test is believed to show the highest sensitivity and specificity regarding the diagnosis of SN entrapment [16]. Herein, in an attempt to describe patients with pathology located merely in the piriformis anatomic area, the above clinical tests represented the inclusion criteria and all patients with spinal pathologies related to symptoms were excluded from the study.

The "gold standard" imaging investigation of PMs remains unclear. There is limited number of reports con-

cerning MR imaging findings in patients with PS, supporting that PM enlargement represents the most frequently described abnormality [17]. In a recent study including a large number of patients, it was shown that in 64% of patients with symptoms suggesting PMs, the imaging studies show the underlying cause [18]. Although the paper mentioned above is a prospective study whereas the present study is retrospective, prevalence of secondary causes prevail and PM enlargement and abnormal signal intensity as well as sciatic neuritis show comparable results. Minor differences could be explained on the grounds of different number of examinees. MR neurography (MRN) has been reported as a valuable method for the diagnosis of PS. Previous studies have suggested that PM enlargement and SN hyperintensity at the level of the sciatic notch show high specificity and sensitivity (93% and 64% respectively) in distinguishing patients with PS from those with similar symptoms [14, 19]. In the cases presented herein, PM abnormal signal intensity represented the most common finding being present in 61% of patients. PM enlargement was seen in 48% while evidence of sciatic neuritis was evident in 35% of them. The latter may be partially attributed to the lack of MRN technique in the imaging protocol used.

Secondary aetiologies were identified in 56.5% of patients. Although research has mainly focused on the imaging of primary PMs, secondary aetiologies of SN irritation in the region of the greater sciatic foramen have not been emphasised and have been sporadically reported mainly in case reports and small case series [7-12].

Limitations of the present study include its retrospective nature, inhomogeneous imaging technique due to different scanners and the rather small number of patients. The major strength of the study is the inclusion of patients of three different countries, making a representative clinical demonstration of the PMs, in various health care practices.

In conclusion, based on the experience presented herein, we aim to increase the clinical awareness of PMs. We suggest that in patients presenting with signs of sciatic neuropathy with no spinal abnormalities explaining their symptomatology, PMs should be considered as a potential diagnosis. In such cases, we propose it would be prudent if further investigation is carried out with MR imaging. R

Conflict of interest

The authors declared no conflicts of interest.

References

1. Hof JJ, Kliot M, Slimp J, et al. What's new in MRI of peripheral nerve entrapment? *Neurosurg Clin N Am* 2008; 19: 583-595.
2. Hernando MF, Cerezal L, Pérez-Carro L, et al. Deep gluteal syndrome: Anatomy, imaging, and management of sciatic nerve entrapments in the subgluteal space. *Skeletal Radiol* 2015; 44: 919-934.
3. Kulcu DG, Naderi S. Differential diagnosis of intraspinal and extraspinal non-discogenic sciatica. *J Clin Neurosci* 2008; 15: 1246-1252.
4. Papadopoulos EC, Khan SN. Piriformis syndrome and low back pain: A new classification and review of the literature. *Orthop Clin North Am* 2004; 35: 65-71.
5. Windisch G, Braun EM, Anderhuber F. Piriformis muscle: Clinical anatomy and consideration of the piriformis syndrome. *Surg Radiol Anat* 2007; 29: 37-45.
6. Boyajian-O'Neill LA, McClain RL, Coleman MK, et al. Diagnosis and management of piriformis syndrome: an osteopathic approach. *J Am Osteopath Assoc* 2008; 108: 657-664.
7. Hettler A, Böhm J, Pretzsch M, et al. Extragenital endometriosis leading to piriformis syndrome. *Nervenarzt* 2006; 77: 474-477.
8. Papadopoulos SM, McGillicuddy JE, Albers JW. Unusual cause of 'piriformis muscle syndrome'. *Arch Neurol* 1990; 47: 1144-1146.
9. Park JH, Jeong HJ, Shin HK, et al. Piriformis ganglion: An uncommon cause of sciatica. *Orthop Traumatol Surg* Res 2016; 102: 257-260.
10. Kitagawa Y, Yokoyama M, Tamai K, et al. Chronic expanding hematoma extending over multiple gluteal muscles associated with piriformis syndrome. *J Nippon Med Sch* 2012; 79: 478-483.
11. Geelen JA, de Graaff R, Biemans RG, et al. Sciatic nerve compression by an aneurysm of the internal iliac artery. *Clin Neurol Neurosurg* 1985; 87: 219-222.
12. Murphy DR. Transitional cell carcinoma of the urethra [correction of ureter] in a patient with buttock pain: A case report. *Arch Phys Med Rehabil* 2008; 89: 150-152.
13. Petchprapa CN, Rosenberg ZS, Sconfienza LM, et al. MR imaging of entrapment neuropathies of the lower extremity. Part 1. The pelvis and hip. *Radiographics* 2010; 30: 983-1000.
14. Filler AG, Haynes J, Jordan SE, et al. Sciatica of nondisc origin and piriformis syndrome: Diagnosis by magnetic resonance neurography and interventional magnetic resonance imaging with outcome study of resulting treatment. *J Neurosurg Spine* 2005; 2: 99-115.
15. Russell JM, Kransdorf MJ, Bancroft LW, et al. MRI of the sacral plexus and piriformis muscles. *Skeletal Radiol* 2008; 37: 709-713.
16. Martin HD, Kivlan BR, Palmer IJ, et al. Diagnostic accuracy of clinical tests for sciatic nerve entrapment in the gluteal region. *Knee Surg Sports Traumatol Arthrosc* 2014; 22: 882-888.
17. Lee EY, Margherita AJ, Gierada DS, et al. MRI of piriformis syndrome. *AJR Am J Roentgenol* 2004; 183: 63-64.
18. Vassalou EE, Katonis P, Karantanas AH. Piriformis muscle syndrome: A cross sectional imaging study in 116 patients and evaluation of therapeutic outcome. *Eur Radiol* 2018; 28: 447-458.
19. Lewis AM, Layzer R, Engstrom JW, et al. Magnetic resonance neurography in extraspinal sciatica. *Arch Neurol* 2006; 63: 1469-1472.

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