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SCIENTIFIC ARTICLE

Surgical evaluation of magnetic resonance imaging findings in piriformis muscle syndrome

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Abstract
Objective The objective of this study was to evaluate the accuracy of magnetic resonance imaging (MRI) in the diagnosis of the piriformis muscle syndrome (PMS).
Materials and Methods In ten patients, seven female and three male, with a long history of clinical symptoms of the PMS, an MRI was performed as the last preoperative diagnostic tool. All patients were imaged using 2T MR system (Elscint, Haifa, Israel). Axial and coronal spin-echo, fast spin-echo (FSE), and fat-suppressed FSE-weighted images were made through the pelvic region with 3-mm section thickness and a 0.5-mm gap to show the whole piriformis muscle and the course of sciatic nerve on its way out of the pelvis. A routine examination also included axial fast spin-echo T2, three-dimensional gradient echo.
Results In seven cases, an MRI abnormality for the PMS was found. In two women, the MRI demonstrated a bigastric appearance of the piriformis muscle with a tendinous portion between the muscle heads and the course of the common peroneal nerve through the muscle between the tendinous portions of the muscle. In one female patient, the common peroneal nerve passed through the hypertrophied piriformis muscle. In four patients, the MRI showed a hypertrophied aspect of the piriformis muscle and an anteriorly displaced sciatic nerve. All MRI findings were confirmed surgically. In three patients, no apparent abnormalities could be observed, but after a surgical treatment, i.e., a tenotomy of the piriformis muscle and neurolysis of the sciatic nerve, all symptoms disappeared.
Conclusion In piriformis muscle syndrome, MRI may demonstrate signal abnormalities of the sciatic nerve as well as its relationship with the normal and abnormal piriformis muscle.

Keywords Sciatic nerve entrapment · Piriformis syndrome · MRI diagnosis

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Introduction

The sciatic nerve passes through the greater sciatic foramen in the proximity of the piriformis muscle. The piriformis muscle splits the foramen into the suprapiriformis region and the infrapiriformis region or foramen (Fig. 1). The infrapiriformis foramen is triangular in shape and two groups of neurovascular structures leave the pelvis through it. The medial group includes the pudendal neurovascular bundle, and the lateral group consists of the sciatic nerve, the inferior gluteal nerve, the posterior cutaneous nerve of the thigh, and the inferior gluteal vessels. The sciatic nerve represents two terminal nerves of the sacral plexus, the tibial nerve and the common peroneal nerve, and it enters the thigh as one of the two nerves. A study by Pecina M et al. [1] revealed an intrapelvic division of the sciatic nerve in 26.5% of the cases, a postforamen division in 4.6% of the cases, a division at the inferior border of the gluteus maximus muscle in 11.5% of the cases, and a division in the thigh in the rest of the cases.

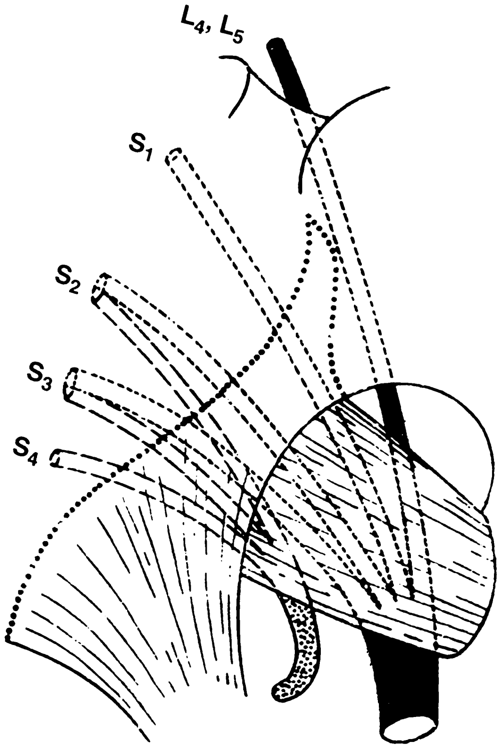

Fig. 1 The sciatic nerve lies near the anterior surface of the piriformis muscle and can even run through it in several variations

Occasionally, the common peroneal nerve can pass through the piriformis muscle, separating the muscle into two bellies. The two bellied piriformis muscle has been shown to exist in 18% of the population [2]. The contents of the infrapiriformis foramen and their relative volumes play major roles in the development of nerve compression. The size of the piriformis muscle belly may vary greatly, thereby narrowing the foramen. Compression in this fibro-musculo-osseous foramen may result in entrapment neuropathy of the sciatic nerve known clinically as the "piriformis muscle syndrome"(PMS) [1]. According to Pecina [2], the development of the PMS secondary to muscle irritation can be divided into four groups as shown in Table 1.

Table 1 Etiologies of the piriformis syndrome due to irritation of the sciatic nerve

Etiologies of piriformis syndrome
Muscle spasm secondary to irritation of the piriformis at either its origin by sacroiliac disease or at its insertion by bursitis or trochanteric disease
Inflammatory or degenerative changes of the muscle, tendon, or fascia
Blunt trauma to the buttock and a hematoma formation and subsequent scarring between the sciatic nerve and the short external rotators
Anomalies in the course of the nerve through muscle or between the tendon of the muscle and the bone (the vascular structures may be also affected)

Although this condition, characterized by pain and paresthesias located in the buttock and often radiating to the posterior thigh, is considered rare, approximately 6% of lower back pain and sciatica cases seen in general practice may be caused by the pressure exerted on the sciatic nerve by the piriformis muscle [3]. As the PMS has many symptoms similar to and overlapping with the symptoms of lower back pain, ischialgia, vascular disease, and lower extremity pathologies, it remains an underdiagnosed cause of sciatica. Frequently, the diagnosis requires elimination of other causes of sciatic nerve impingement or irritation based on medical history and physical examination. Benson and Schutzer [4] stressed that because of the lack of a widespread understanding of this condition in the medical and orthopedic communities and the lack of reliable objective tests to identify it, patients have lengthy delays in diagnosis and additional expenses related to misleading diagnostic tests and time lost from work and endure unnecessary suffering.

Magnetic resonance imaging (MRI) can show the anatomic-topographical relationship between the piriformis muscle and sciatic nerve and detect changes in signal intensity and appearance of nerves, their surrounding, and place and cause of nerve compression. There are only few MRI presentations of the PMS with heterogeneous results and, until recently, without surgical evaluation of MRI findings [5–11].

The aim of our study was to surgically evaluate the accuracy of MRI in the diagnosis of PMS.

Material and methods

In ten patients, seven female and three male, 17–57 years of age, with a long history of clinical symptoms of the PMS (6 to 72 months), an MRI was performed as the last preoperative diagnostic tool. The average time from the beginning of the symptoms to the surgical procedure was 23 months. The study group consisted of patients with a clinically proven PMS in whom other causes of low back pain were excluded by an MRI of the lumbar spine, electromyoneography, and clinically differentiating symptoms, signs, and tests of the PMS. The research was performed following the Declaration of Helsinki principles and an informed consent was obtained from every patient before the surgical procedure.

Each patient had at least one MRI scan of the lumbar spine. An MRI of the pelvis with special regard to the relationship of the sciatic nerve and piriformis muscle was performed as the last preoperative diagnostic tool. All patients underwent MRI on a 2.0 T Elscint Prestige Unit (Elscint, Haifa, Israel) with a pelvic coil. Each patient was scanned with both conventional spin-echo and fast spin-echo sequences with fat suppression in the coronal and sagittal planes. The images were made through the pelvic region to show the whole piriformis muscle and course of the sciatic nerve on its way out of the pelvis. Fast spin-echo imaging was performed with an echo train of 14. Time to repeat–time to echo was 5.200/126, and scanning lasted 4.41 min. For spin-echo sequence, time to repeat–time to echo was 550/12 and scanning lasted 4.20 min. A 256×256 matrix with two image excitations was used to generate both the conventional and fast spin-echo sequences with fat suppression, with 3-mm section thickness and a 0.5-mm gap. A routine examination also included axial fast spin-echo T2, three-dimensional gradient echo, taking approximately 35 min.

The surgical intervention was performed with patients in the lateral decubitus position using a shortened posterior approach to the hip. The piriformis muscle and sciatic nerve were identified and their relationship was investigated, followed by sectioning of the piriformis muscle at its tendinous insertion to the great trochanter. External neurolysis of the sciatic nerve was performed in all patients and, eventually, the persistent adhesions between the sciatic nerve and piriformis muscle and its surroundings were loosened.

Surgical findings were compared with the preoperative MRI findings.

Results

Pathological findings for PMS was confirmed in seven patients. In two women, the MRI demonstrated a bigastric appearance of the piriformis muscle with a tendinous portion between the muscle heads and course of the common peroneal nerve through the muscle between the tendinous portions of the muscle (Fig. 2). In one female patient, the common peroneal nerve passed through the hypertrophied piriformis muscle (Fig. 3) In two male and two female patients, the MRI showed a hypertrophied of the piriformis muscle and an anteriorly displaced sciatic nerve (Fig. 4). All MRI findings were confirmed surgically. In three patients, no apparent anatomic or morphologic abnormalities could be observed, but after a surgical treatment, i.e., a tenotomy of the piriformis muscle and neurolysis of the sciatic nerve, all symptoms disappeared. In one of these three patients, the fibrous band parallel to the lower margin of the piriformis muscle was found, which was not identified on MRI. In the other two patients, an adhesion between the sciatic nerve and piriformis muscle was observed.

Discussion

In 1928, Yeoman [12] described the importance of the neuromuscular relationship in the development of lumbosacral neuralgia and stated that "insufficient attention" had been paid to the piriformis muscle as a potential cause of sciatica. Freiberg and Vinke and others [13–15] have since seconded this opinion. Many authors have asserted that there is a causal relationship between certain anatomical variations of the sciatic nerve and piriformis muscle and the development of PMS [2, 11, 16, 17]. Knowledge of the anatomy of the sciatic nerve and its relationship to the piriformis muscle and gluteal vessels makes it easier to understand the clinical picture of the entrapment of the nerve in the infrapiriformis foramen [18]. According to many authors, because of the lack of strict diagnostic criteria, PMS remains a controversial clinical entity and should be suspected as a part of the differential diagnosis in cases of low back and hip or thigh pain [1, 10, 17]. It should be emphasized again that PMS is a seldom seen and/or verified condition and is a diagnosis of exclusion [19]. In the differential diagnosis of sciatica and buttock pain, especially when the standard workup for a spinal cause of pain is negative, MRI, computed tomography

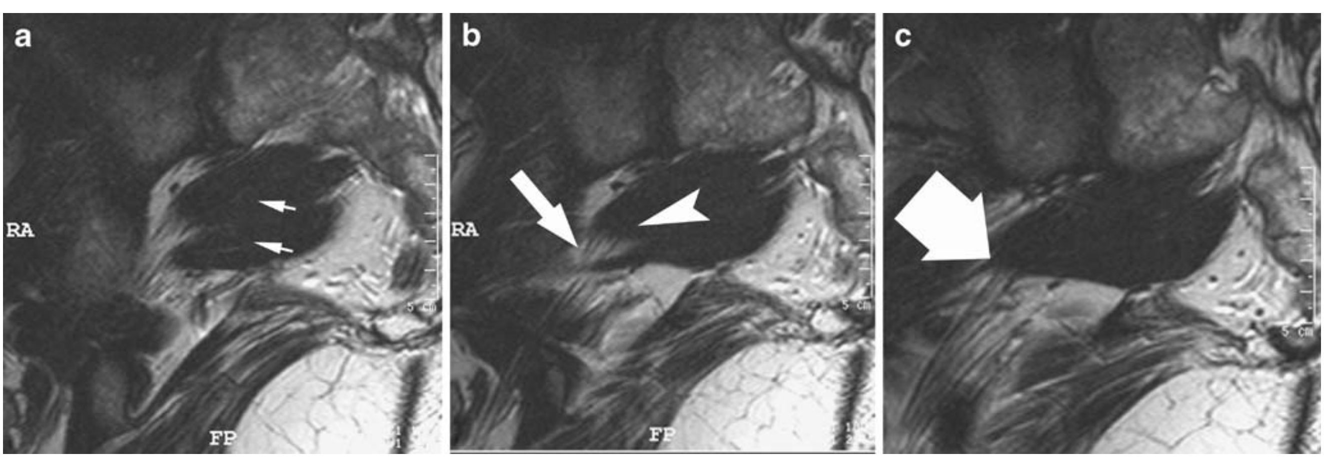

Fig. 2 Coronal oblique T2-weighted FSE image shows two heads (*small arrows*) of the divided right piriformis muscle and a tendinous portion between the muscle heads (**a**); Course of the common peroneal nerve which seams more fat than normal (*large arrow*) through the right piriformis muscle between the tendinous portion (*arrowhead*) of the muscle (**b**); Common peroneal nerve (*wide arrow*) passing through the normal monogastric left piriformis muscle (**c**)

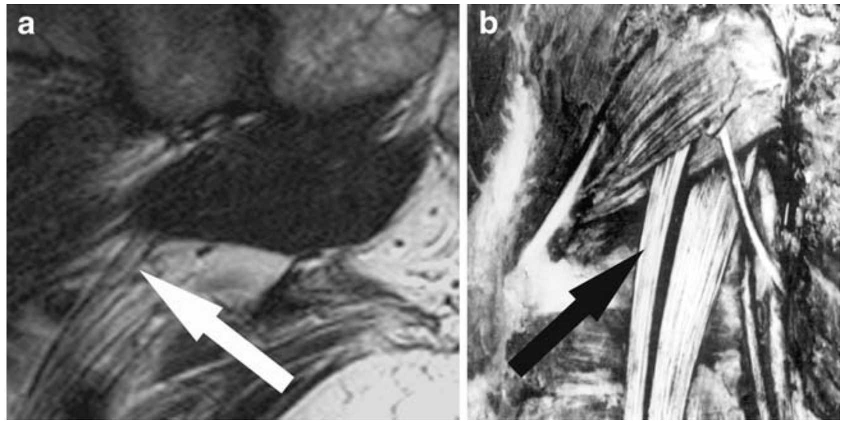

Fig. 3 Coronal oblique T2-weighted FSE image shows the common peroneal nerve (*arrow*) passing through the hypertrophied piriformis muscle (**a**). The same situation is noted on anatomic specimens (**b**). Comparison of **a** and **b** confirms that MRI presentation is very reliable

(CT), or electromyographic studies of the sciatic notch area can be performed [6, 10, 11, 20]. According to Rossi et al. [10], an MRI may provide sophisticated anatomic images in and around the muscles and may help document directly piriformis muscle abnormalities, as was the case in our seven out of ten surgically evaluated patients.

A group of asymptomatic patients was not present in our study because we could not justify performing an MRI of the pelvis in asymptomatic patients. We are aware that it would be very useful to provide standard MRI findings of the anatomic and topographical relationships between the piriformis muscle and sciatic nerve, including standard dimensions of the piriformis muscle. It would make it easier to determine if a hypertrophied or enlarged piriformis muscle is the cause of PMS. The width of the piriformis muscle belly in four of our patients in whom we diagnosed a hypertrophied piriformis muscle was always at least 20% larger on the symptomatic side, as compared to the asymptomatic side.

Only a small number of MRI reports on PMS with conflicting results are available. Jankiewicz et al. [6] reported a patient with an enlarged piriformis muscle with normal signal intensity. Barton [5] performed an MRI of the pelvis in two patients without showing any abnormality of the piriformis muscle which was confirmed by surgical exploration in one patient. Sayson et al. [11] found no evidence of a soft tissue lesion in their patient using MRI, but surgical findings revealed a fibrous constricting band around the sciatic nerve. Rossi et al. [10] reported a case of a woman in whom the clinical suspicion of the PMS was confirmed by an MRI of the pelvis, which showed enlargement of the piriformis muscle with an anterior displacement of the sciatic nerve. Spinner et al. [17] described a case of a female patient who had been examined by ten physicians and underwent serial electrophysiological tests and radiographs. MRI of the pelvis and lumbar spine and CT myelograms all demonstrated normal findings, but she had clinical features suggestive of the PMS. During surgery, the patient was found to have a rare variation in anatomical structure, in which the peroneal nerve was displaced by the piriformis muscle, which was not recognized during the MRI of the pelvis. An anomalous sacral attachment of the right piriformis muscle, with accessory muscle fibers extending medially over the S2 foramen and crossing over the right S2 nerve, was reported by Lee et al. [8]. Surgical exploration revealed the sciatic nerve compressed by the piriformis muscle crossing anterior to the right S2 nerve root. In four patients who underwent a surgical exploration and decompression of the sciatic nerve in the study by Lewis et al., the evidence of the entrapment by the piriformis muscle or an associated fibrous band was found [9]. Three of those patients had an increased STIR sequence signal in the ipsilateral sciatic nerve, and one had normal MRI findings. Unfortunately, we did not use STIR sequence in our patients, but it will be included in the MRI protocol for our future patients. Lastly, in a patient from a case report by Kosukegawa et al. [7], the MRI revealed only a hypertrophy of the right piriformis muscle, which the CT scan after a perineurography of the sciatic nerve showed as an anteroposterior division of the piriformis muscle into two

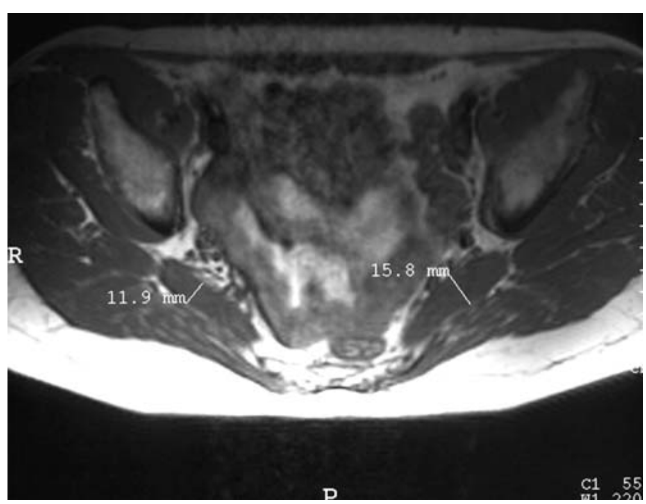

Fig. 4 Axial T2-weighted FSE image shows a hypertrophied aspect of the left piriformis muscle (15.8 mm) contrary to the right piriformis muscle (11.9 mm) and the slightly anteriorly displaced sciatic nerve

lobes. A surgical exploration confirmed the CT findings and found the sciatic nerve running between the two lobes. According to Rosenberg and Cavalcanti [21], MRI findings have proven useful in the diagnosis of entrapment neuropathy of the lower extremities, and, in some cases, they were even crucial in setting a causal diagnosis of a peripheral nerve compression.

We were able to intraoperatively confirm the preoperative MRI findings indicating a possible cause of PMS occurrence in seven out of ten patients with a clinical picture of PMS in whom other causes of sciatica were excluded. Of course, it is questionable if the preoperative MRI findings point to the exact cause of the PMS, as in the three cases with normal preoperative findings the clinical symptoms of PMS completely disappeared after the surgery.

Based on the current literature and our experience, we consider that MRI can show the anatomic relationship between the piriformis muscle and sciatic nerve and that the method is quite accurate in detecting a possible cause of nerve compression in PMS and may be used as the first imaging modality for preoperative planning.

Conclusion

In piriformis muscle syndrome, MRI may demonstrate signal abnormalities of the sciatic nerve as well as its relationship with the normal and abnormal piriformis muscle.

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