




# What abdominal radiologists should know about extragenital endometriosis-associated neuropathy

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## Abstract

**Purpose** The aim of this study is to provide an overview of endometriosis-associated neuropathy and to review main anatomical concepts of intrapelvic peripheral nerves.

**Methods** In this pictorial essay, we review the anatomy of pelvic nerves and imaging features of endometriosis-associated neuropathy. We also evaluate clinical findings, imaging features, and outcome of seven patients with endometriosis-associated neuropathy.

**Results** Nerve involvement by endometriosis is rare and may manifest with neurological symptoms, including pain, muscle weakness, bowel and bladder incontinence, and paraplegia. The neural involvement may be isolated or caused by a direct extension of a deep infiltrating endometriosis of the pelvic structure. Magnetic resonance imaging (MRI) is a reliable imaging modality for detecting neural involvement of endometriosis. On MRI, the main imaging features are retractile fibrous tissue and endometriomas. The signal intensity of the endometriotic tissue may vary depending on the age of the hemorrhage and the proportion of endometrial cells and stroma. Early diagnosis and treatment may avoid permanent neural damage.

**Conclusion** Considering that patients with endometriosis usually undergo pelvic MRI, which is generally reported by a non-musculoskeletal-trained radiologist, abdominal radiologists need to be familiar with the pelvic nerve anatomy and the possible patterns of presentation of neural endometriosis. Early diagnosis may obviate permanent nerve damage and MRI is a reliable tool for the diagnosis.

**Keywords** Endometriosis · Magnetic resonance imaging · Pelvic pain · Neuralgia

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## Introduction

Endometriosis is a common gynecological disease, which affects women of reproductive age. In general, the prevalence of endometrioses is around 2–10% [1, 2]; whereas in women with pelvic pain and/or infertility the prevalence may reach up to 35–50% [1]. It is defined as the presence of functional endometrial glands and stroma outside the uterine cavity. In response to hormonal stimulation, the ectopic endometrial tissue may present cyclic hemorrhagic transformation during menstruation, which trigger local inflammatory reaction and scar formation. It is believed that depending on genetic and epigenetic changes different types of expressions of the disease may occur [1, 3]. Clinical symptoms are variable; being dysmenorrhea, chronic pelvic pain, dyspareunia, and infertility the most frequent ones.

Deep pelvic endometriosis is defined as endometriotic lesion extending more than 5 mm underneath the peritoneum [4]. The following structures can be involved: uterosacral ligaments, vagina, gastrointestinal tract (mainly rectum and rectosigmoid), rectovaginal septum, and urinary tract (generally bladder and ureters) [4, 5]. Nerve involvement by endometriosis is rare and its prevalence is limited to case reports [6–15]. Despite its rarity, it has a significant clinical relevance, considering the potential sensory and motor symptoms that cause impairment in quality life, and the difficulties for treatment.

Early diagnosis of neural involvement in endometriosis is of key relevance, since early treatment may avoid irreversible nerve damage and chronic sensorimotor neuropathy. Although neural endometriosis is most commonly diagnosed by histological examination, it is possible to provide a reliable diagnosis of neural endometriosis based on imaging findings, especially magnetic resonance imaging (MRI). However, endometriosis-associated neuropathy is often overlooked and under-diagnosed, which may be due to low clinical suspicion and lack of familiarity with neural anatomy among abdominal radiologists.

The aim of this study is to review the anatomy of pelvic nerves, current literature of endometriosis-associated neuropathy and their MRI imaging features. We also present seven cases of women with pelvic, lumbar and lower limb pain due to endometriosis neural involvement.

## Anatomy

The lumbosacral plexus is a network of nerves that supply the lower extremity and the pelvic wall and is formed by the conjunction of the lumbar and sacral plexuses, which are connected by the lumbosacral trunk (Fig. 1). The course and anatomical relationships of the nerves of the

lumbosacral plexus are highly predictable, except in cases with anatomical variants [16, 17].

The lumbar plexus is formed by the branches of L1–L3 and part of L4. These rami cluster within or posterior to the body of the psoas major, anterior to the L2–L5 transverse processes, and then exit into the pelvis. This plexus originates the obturator nerve and the femoral nerve, in addition to several short branches (such as iliohypogastric, ilioinguinal, genitofemoral, and lateral femoral cutaneous nerves) that exit the psoas laterally and many times are too small to be reliably visualized [18].

The femoral nerve is the largest branch of the lumbar plexus, originating from the L2–L4 nerve roots. It exits the psoas major laterally and runs inferolaterally between psoas major and iliacus (Fig. 2) [19, 20].

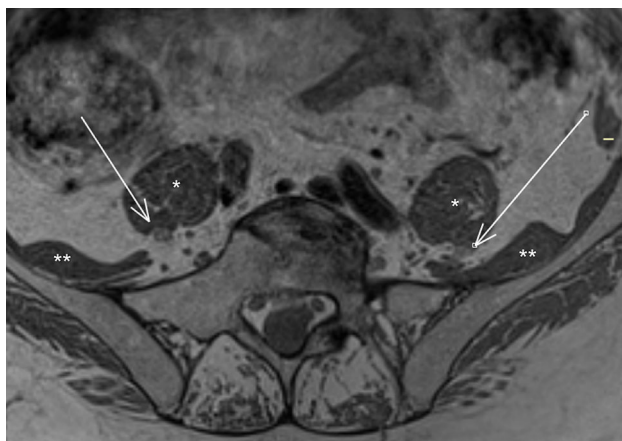
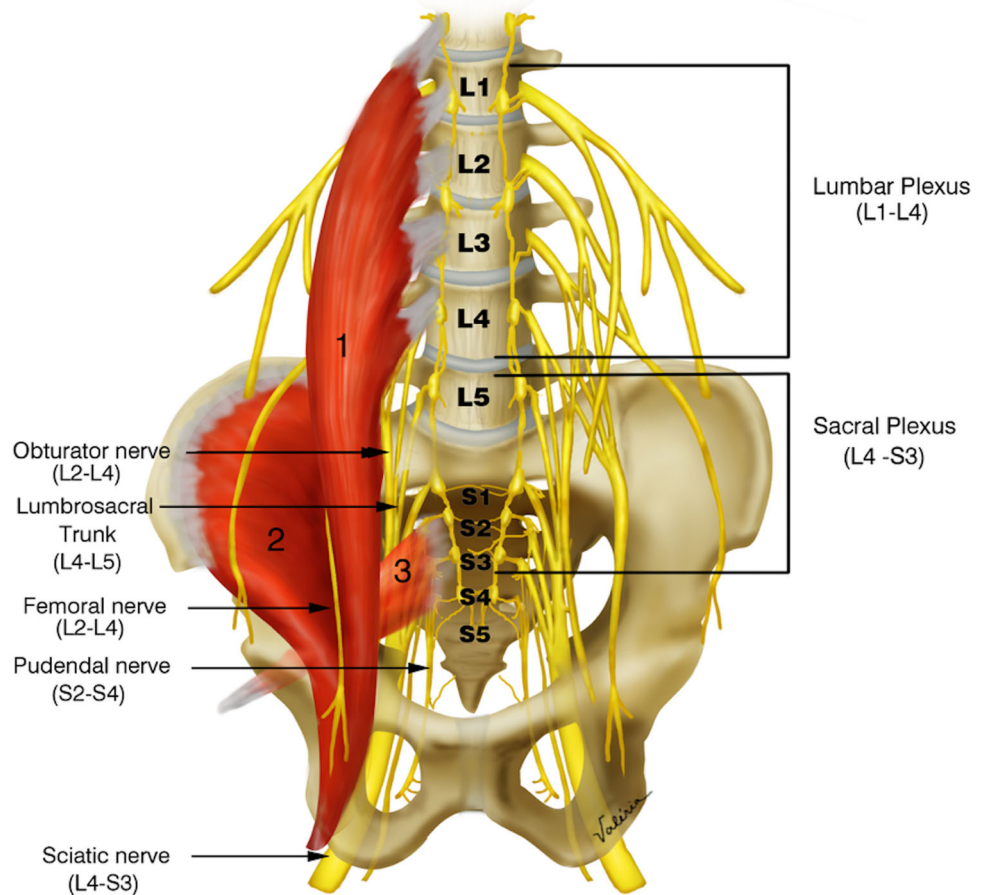
The obturator nerve arises from the ventral rami of L2–L4. It descends medial to the psoas major and runs immediately lateral to the sacrum, coursing laterally along the pelvic brim. It joins the obturator vessels and runs through the superolateral aspect of the obturator foramen within the obturator vessels canal to enter the obturator canal (Fig. 3a). Within the canal it splits into its anterior division, that exits the obturator canal to enter the medial compartment of the thigh, and the posterior division, that exits through obturator externus muscle (Fig. 3b) [18].

The remainder L4 and L5 roots join to form the lumbosacral trunk, which fuses with sacral branches S1–S4, with contributions from the first coccygeal nerve, to form the sacral plexus. The sacral plexus courses on the anterior surface of the piriform muscle, making it the key anatomic landmark for locating the sacral plexus and sciatic nerve (Fig. 1).

The sacral plexus gives rise to the sciatic, superior gluteal, inferior gluteal, pudendal, and posterior femoral cutaneous nerves. The posterior femoral cutaneous, superior gluteal, and inferior gluteal nerves are too small to be reliably visualized on standard MRI. The sciatic nerve is formed by the ventral roots of L4–S3. It courses laterally either above, anterior or directly through the piriformis muscle (Fig. 4a). It then leaves the pelvis through the greater sciatic foramen, curves posteriorly around the ischial spine, and runs lateral to the common hamstring tendons, between the greater trochanter of the femur and the tuberosity of the ischium (Fig. 4b).

The pudendal nerve is formed by the ventral rami of S2–S4 along with the first coccygeal nerve. It has a short intrapelvic course and exits the pelvis through the greater sciatic foramen, between the piriformis muscle and ischio-coccygeal ligament. It then curves medially along the ischial spine and re-enters the pelvis through the lesser sciatic foramen (Fig. 5a). It joins the internal pudendal vessels and runs along the lateral ischio-rectal fossa within the pudendal (Alcock's) canal bounded by the obturator fascia (Fig. 5b).

**Fig. 1** Schematic drawing of lumbar and sacral plexus and the main pelvic nerves. (1) Psoas muscle, (2) Iliac muscle, (3) Piriform muscle



**Fig. 2** Normal anatomy of the femoral nerve (arrows). Psoas muscle (one asterisk). Iliac muscle (two asterisks)

**Case presentation**

**Demographics and clinical data**

We reported seven cases of patients with chronic pelvic pain who underwent pelvic, hip, or lumbar MRI in our institution. The mean age was 37.8 years old, ranging from

31 to 50 years. Four out of seven (57%) patients had a past history of deep pelvic endometriosis, although only two of them were previously diagnosed. Pelvic pain with a cyclical pattern was reported by 7/7 patients (100%), 4/7 patients (57%) had some motor impairment and another 4/7 patients (57%) also referred sensorial symptoms. One patient (14%) had fecal and urinary incontinence.

**Imaging features on MRI**

The most affected nerve in our patients was the sciatic, which was involved in 4/7 patients (57%) (Cases 1, 4, and 7) and one patient had a concomitant infiltration of pudendal nerve (Case 5). Sacral plexus was infiltrated by endometriosis in 2/7 patients (28%) (Cases 2 and 6) and 1/6 patient (17%) had isolated involvement of pudendal nerve (Case 3).

MRI showed two patterns of neural involvement: an infiltrative retractile tissue occasionally with hemorrhagic foci (Figs. 6, 7, and 8) and a cystic lesion with imaging features of endometrioma (Figs. 9 and 10). In one case (Fig. 11) it was possible to observe direct extension of intrapelvic endometriosis foci to the sciatic nerve. In one



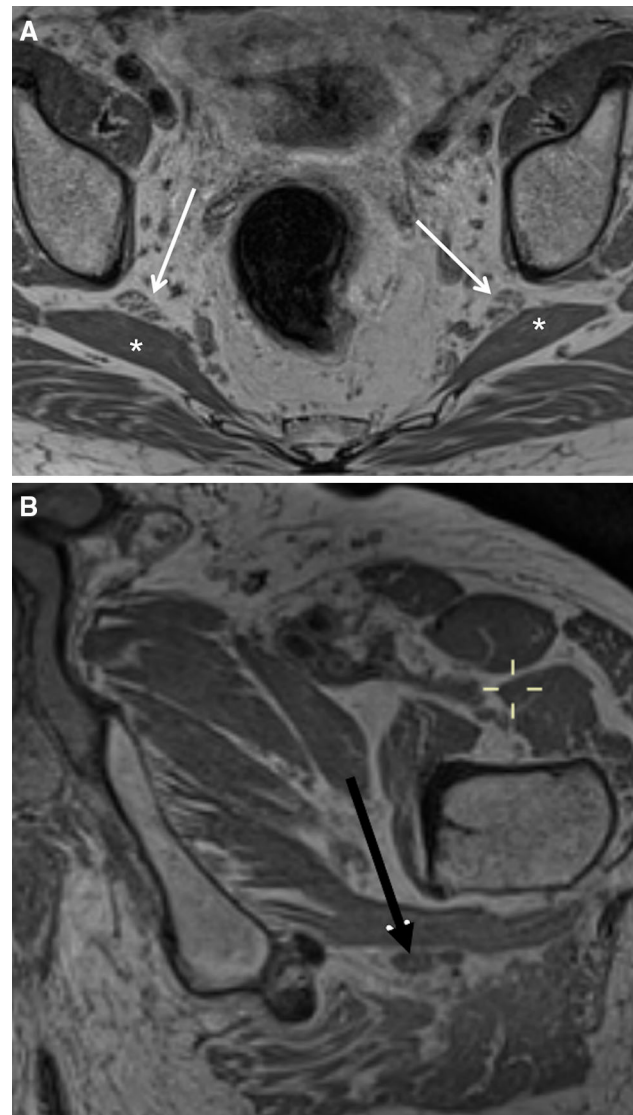
**Fig. 3** Normal anatomy of the obturator nerve. **a** Obturator nerve in the obturator canal (large arrows) and **b** anterior and posterior rami (small arrows)

case (Fig. 11) there was a diffuse neural involvement with homogeneous thickening of the nerve roots. In two cases of chronic nerve involvement, fatty muscle atrophy occurred (Figs. 9 and 12).

### Treatment and outcome

Two patients underwent surgery; one of them reported complete resolution of the symptoms, whereas the other one described partial improvement of symptoms. One patient lost to follow-up and the remaining ones (3/6 patients, 50%) received clinical treatment, including tricyclic antidepressants, GABA analog, hormonal therapy, and physiotherapy.

Table 1 summarizes the clinical and imaging findings of the cases with endometriosis-associated neuropathy.

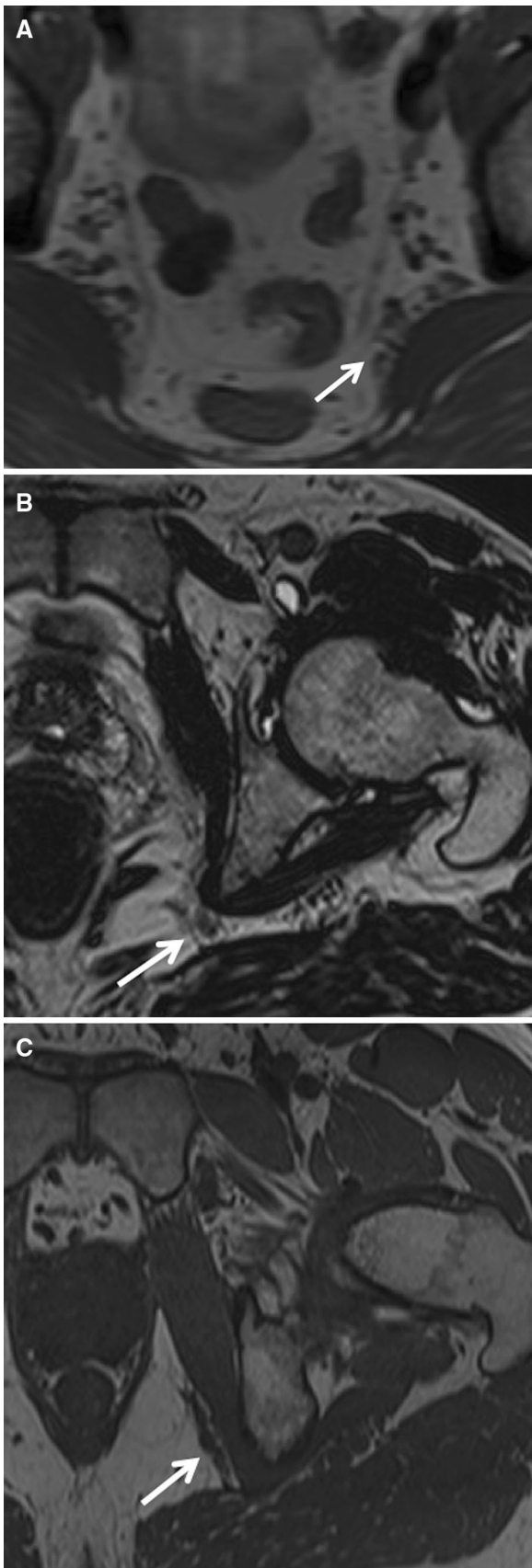


**Fig. 4** Normal anatomy of the sciatic nerve. **a** Sciatic nerve (arrows) anterior to the piriform muscle (asterisks). **b** Sciatic nerve entering the proximal right thigh (black arrow)

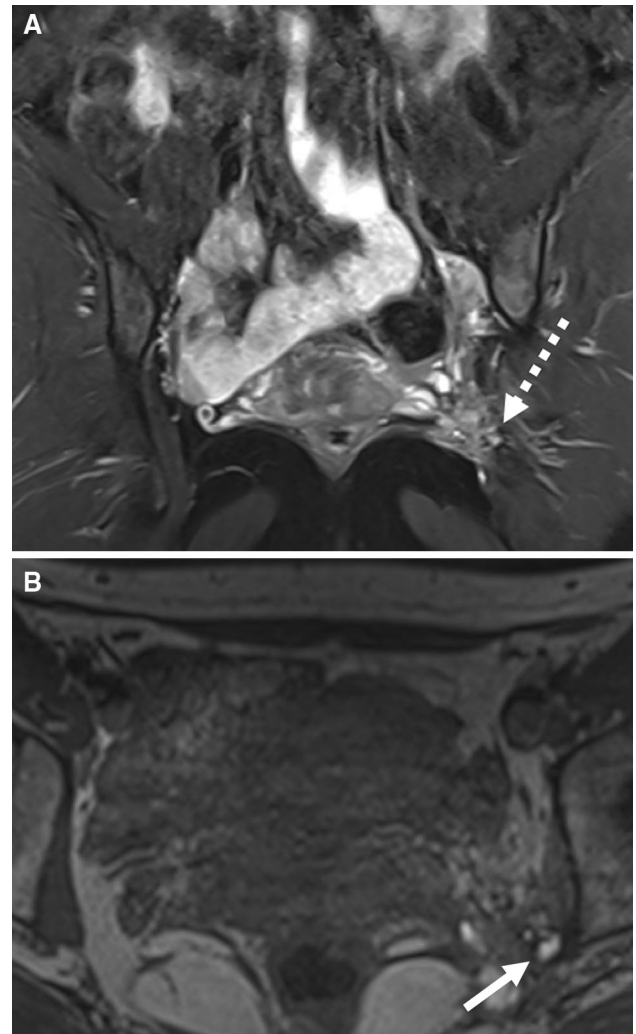
### Discussion

Extragenital endometriosis with neural involvement is uncommon and may manifest with neurological symptoms, including pain, muscle weakness, bowel and bladder incontinence, and paraplegia [7, 12, 13]. Symptoms may be cyclic according to the menstrual cycle and this can be explained by endometrial tissue cyclical hemorrhage, which embraces the peripheral nerves and invades the epineurium and perineurium, causing periodic reactive inflammation. The cyclical inflammation may lead to fibrosis, resulting in adhesions around the nerves and, eventually, permanent neural damage. The neural involvement may be isolated or caused by a direct extension of a deep infiltrating endometriosis of the pelvic





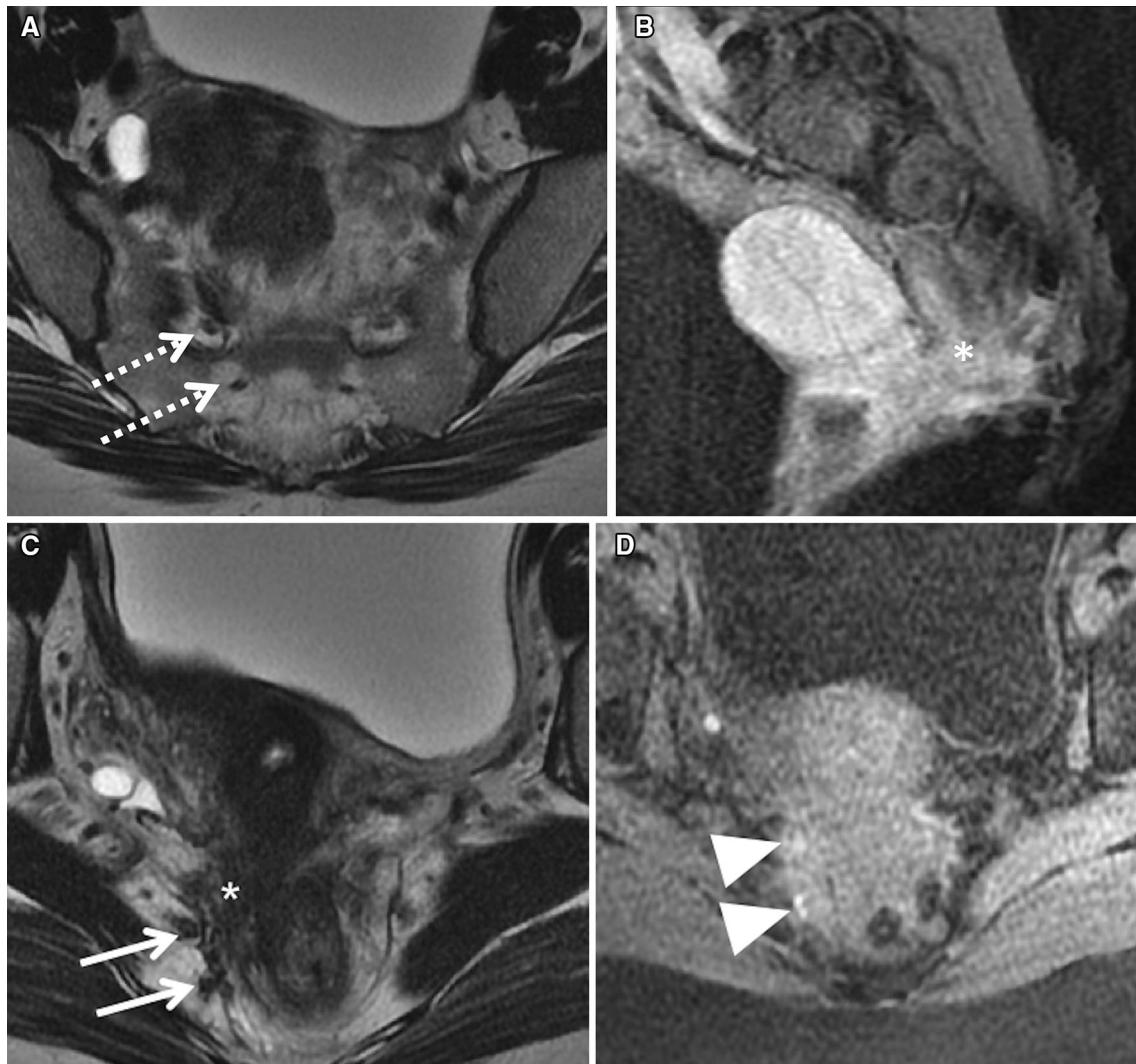
◀**Fig. 5** Normal anatomy of the pudendal nerve. **a** Proximal pudendal nerve **b** pudendal nerve at the ischial spine (arrow) and **c** in the Alcock's canal (arrow)



**Fig. 6** Sciatic nerve endometriosis (Case 1). MRI of the lumbar spine in coronal T2WI with fat suppression (**a**) and pelvis axial T1WI (**b**) shows an infiltrative retractor lesion (dashed arrow) with foci of blood (arrow) located in the left greater sciatic foramen involving the left sciatic nerve

structure. Therefore, the absence of endometriosis elsewhere in the pelvis does not exclude the diagnosis of neural endometriosis [21].

There are many theories about endometriosis-associated neuropathy. The most cited is the existence of a peritoneal diverticulum permitting endometrial cells of the retrograde menstruation to migrate into the nerves from the site of genital endometriosis [7], giving rise to an invagination of



**Fig. 7** Sacral plexus endometriosis (Case 2). T2WI without fat suppression (**a, c**) and T1WI with fat suppression (**b, d**). **a** Normal emerging sacral roots S2 and S3 (dashed arrows). Endometriotic

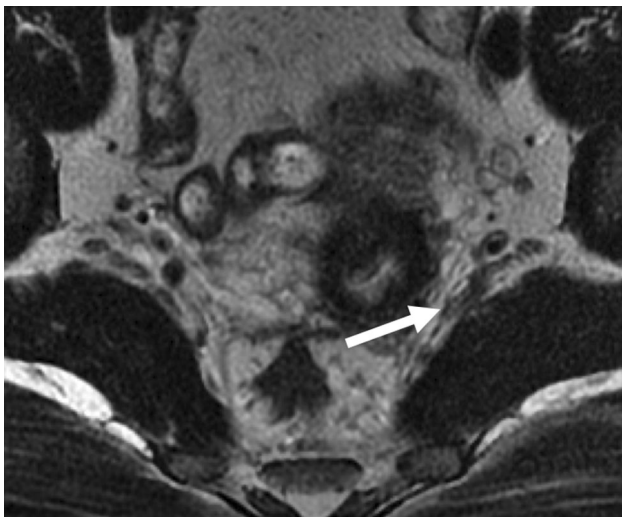
retractor tissue (**b, c** asterisks) involving sacral roots. There is thickening of S2 and S3 sacral roots (**c**, arrows) with hemorrhagic foci (**d**, arrowheads)

the pelvic peritoneum ('pocket sign'). Perineural propagation is another theory for endometriosis of the lumbosacral plexus and nerves, suggested by Possover et al. [11] and Siquara et al. [15], which explains the existence of isolated nerve endometriosis without pelvic organs involvement. Perineural theory is similar to the mechanism of malignant propagation on pelvic cancer, in which there is dissemination from the uterus to the lumbosacral plexus along the pelvic autonomic nerves and further into the periphery along the arborizing nerves or proximally to the spinal nerves or even intradurally [13, 15, 18].

In our study, sacral plexus and sciatic nerves were the most common neural structures involved in endometriosis, which is corroborated by a recent meta-analysis in which 365 cases of somatic peripheral nervous endometriosis

were analyzed and 352 of them affected either the sacral plexus (57%) or sciatic nerve (39%) [15]. The first case report of sciatic nerve endometriosis was published by Schlicke in 1946 [22]. Since that, about 100 additional cases causing cyclic sciatica have been reported [7, 10, 14, 21, 23, 24]. The sciatic nerve infiltration has as major symptom a typical cyclical sciatica with hip pain irradiated to lower limb, which is reported to be as frequent as 97% of cases [15], this cyclical pattern may raise suspicion for the diagnosis [21, 23, 25] and it was presented in 6/6 (100%) of our cases.

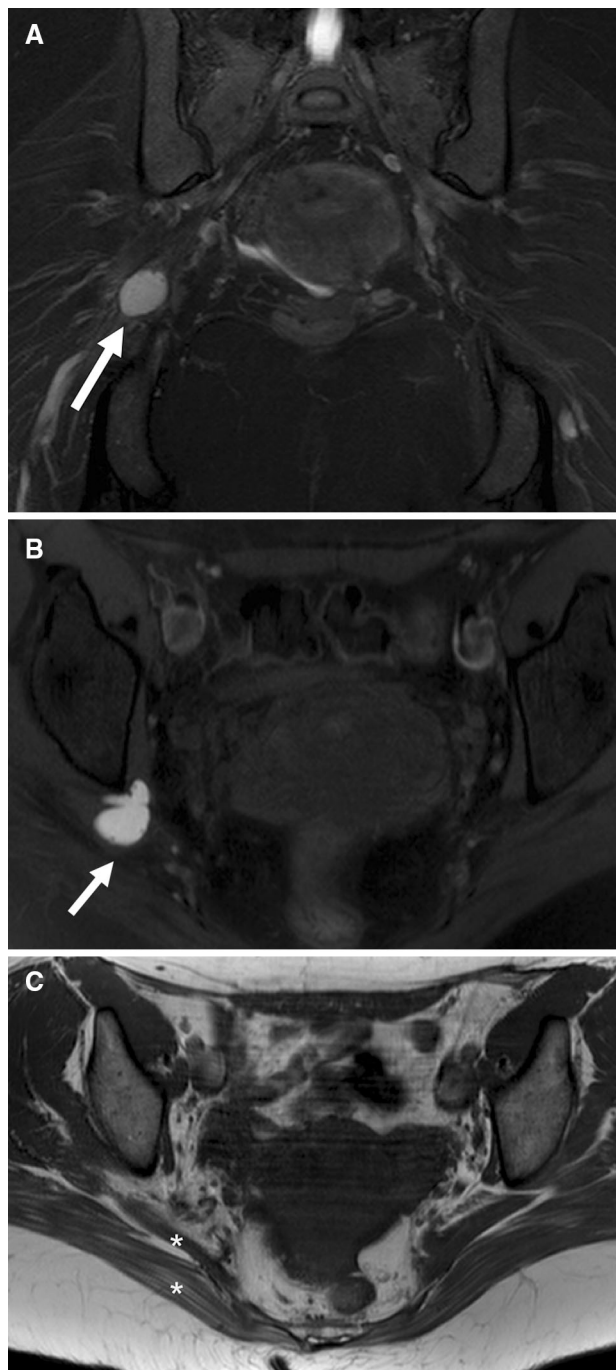
In most published cases, the diagnosis of nerve involvement has been made by histological examination. However, in some cases the diagnosis was clinically suspected by the typical symptoms and then confirmed by



**Fig. 8** Pudendal nerve endometriosis (Case 3). Endometriotic retractor tissue with low signal intensity on axial T2WI involving the proximal pudendal nerve (arrow)

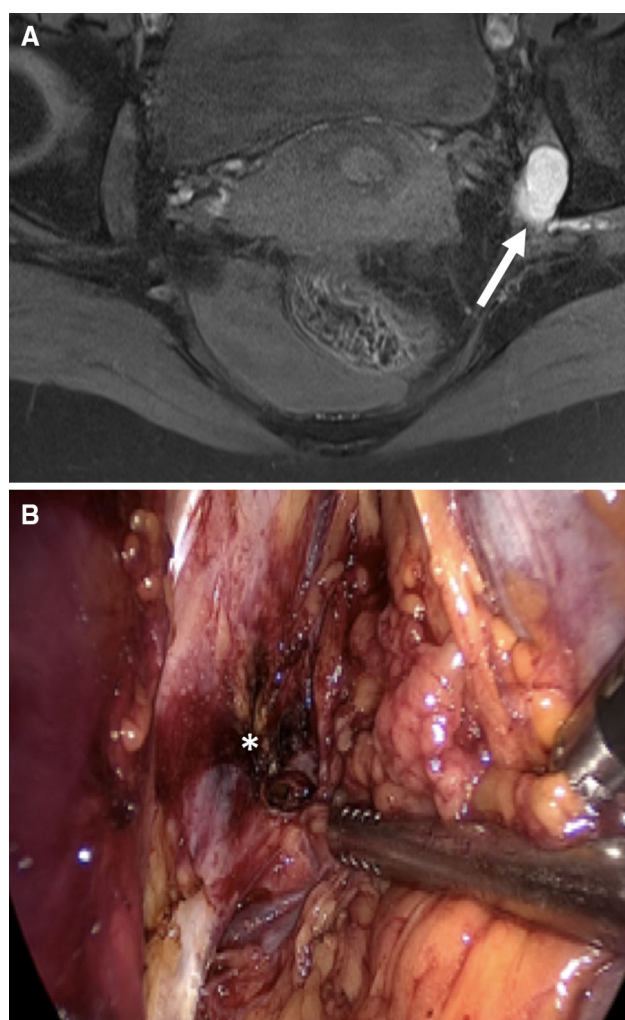
imaging methods or therapy response [21, 25], avoiding invasive procedures [7–9, 15, 21, 25, 26]. In our study, 4/6 (66%) patients had the diagnosis confirmed by MRI and 2/6 (33%) of them had biopsy or video-laparoscopic surgery. Vercellini et al., in a meta-analysis with 63 patients with neural endometriosis, showed that 56/63 (89%) of them had an invasive diagnosis and only 7/63 (11%) were diagnosed based on clinical and imaging findings alone [14].

Table 2 summarizes the current literature of MRI findings in patients with endometriosis-associated neuropathy. The main imaging features on MRI of endometriosis-associated neuropathy are: (a) retractile fibrous tissue with low signal intensity on T1 and T2 weighted images (WI) containing punctate high signal foci originated by hemorrhage that produces degenerated blood products such as methaemoglobin (Figs. 6, 7); and (b) endometrioma (Figs. 8, 9), characterized by high signal intensity on T1WI, low signal intensity on T2WI with an hypointense rim on T1WI and T2WI [27, 28]. The intensity of the signal varies according to the quantity and age of the hemorrhage and the proportion of endometrial cells and stroma [7, 25, 26, 29]. Fat-suppressed sequences are helpful for distinguishing endometriotic foci (blood) from fat-containing lesions, such as teratomas [28]. Typically, neural involvement in endometriosis shows no contrast enhancement; however, some patients with perilesional reactive inflammation may show enhancement [8, 13, 25]. In our



**Fig. 9** Endometrioma in the sciatic nerve with muscle atrophy (Case 4). MRI of the pelvis coronal T2WI with fat suppression (a) and T1WI with fat suppression (b) shows lobulated cystic lesion with well-defined contours and high signal intensity on T1WI and T2WI involving the sciatic nerve in the right greater ischiatic foramen (arrows). Axial T1WI without fat suppression (c) show hypotrophy of the right maximum gluteal and piriform muscles (asterisks), due to chronic nerve damage

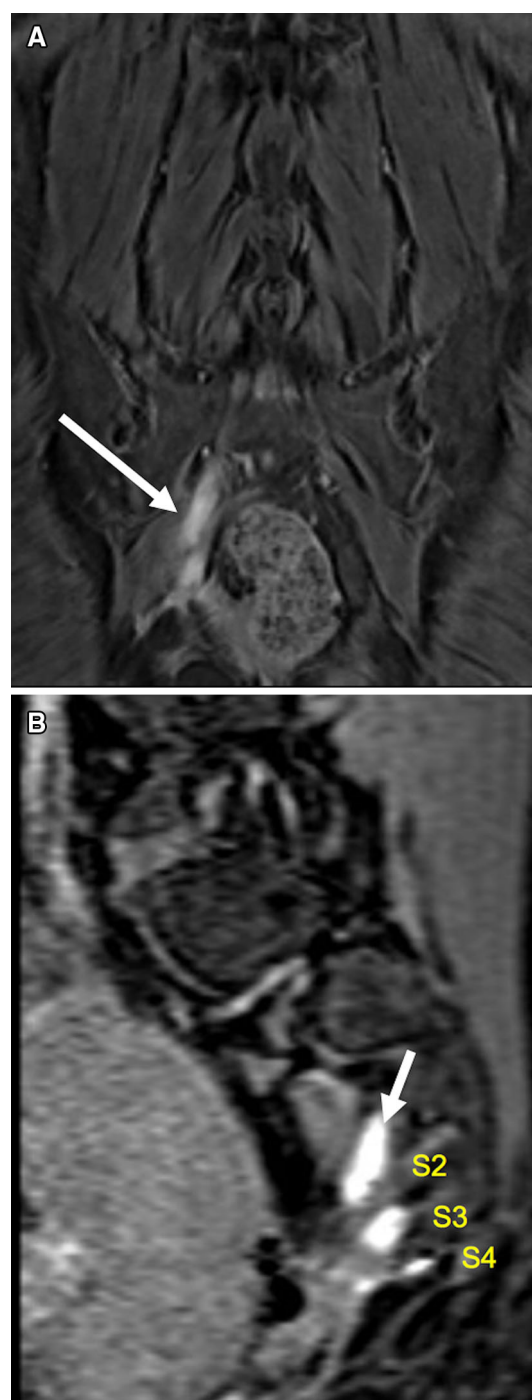




**Fig. 10** Endometrioma of the pudendal nerve (Case 5). **a** MRI of the pelvis on axial T1WI with fat suppression shows lobulated cystic lesion with well-defined contours and high signal intensity on T1WI involving the pudendal nerve at the entrance of the Alcock's canal and the obturator internus muscle. **b** Surgical video-laparoscopic images shows the endometriotic tissue (asterisk) involving the obturator muscle and pudendal nerve

study, infiltrative retractile tissue was the most common MRI findings in contrast with the literature, in which endometrioma was the most common finding. In cases of chronic nerve involvement, fatty muscle atrophy may be depicted.

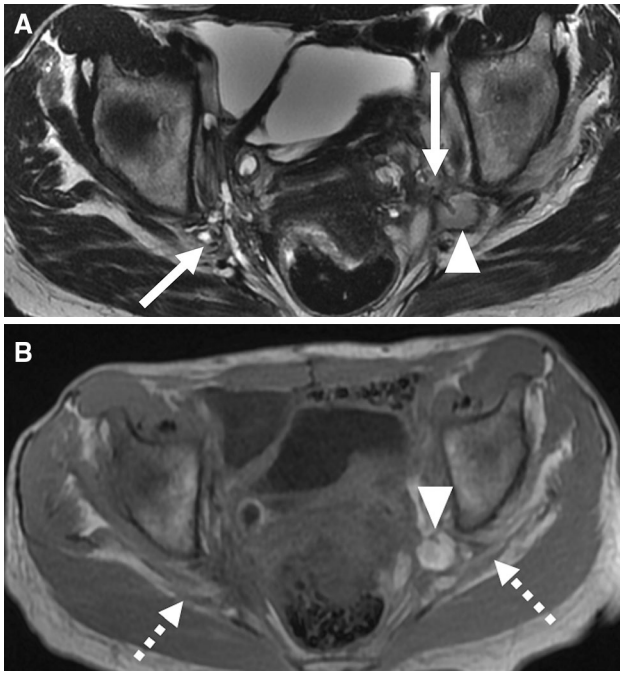
The management of endometriosis requires a multidisciplinary approach with surgery, hormonal treatment with aromatase inhibitor or gonadotrophin releasing hormone analogs, and pain management strategies [5]. Conservative surgery with meticulous dissection and excision of the endometriosis from the nerve root is generally the best choice and is compatible with normal reproductive function. It is recommended for patients with severe or worsening neurologic symptoms, or if there are signs of cauda



**Fig. 11** Sacral plexus endometriosis with diffuse neural root thickening (Case 6). **a** Coronal T1WI with fat suppression pre-contrast and **b** sagittal T1WI with fat suppression post contrast demonstrate diffuse thickening and enhancement of the sacral plexus involving the sacral roots S2, S3 and S4 on their extra-foraminal portions (arrows)

equina syndrome. In our population, two patients (2/6) underwent surgery, one had complete resolution of symptoms and the other described only partial improvement.





**Fig. 12** Sciatic endometriosis with muscle atrophy (Case 7). Axial T2WI (a) and T1WI (b) demonstrated a retractile tissue (arrows) and endometrioma (arrowheads) infiltrating the sciatic nerves and the distal roots of L4–S1. There is also a fatty muscle atrophy of the piriform muscles (dashed arrows), due to chronic nerve damage

Neural endometrioses can mimic other neurological/orthopedic conditions. The most important differential diagnosis of neural involvement is benign neurogenic tumor, including neurinoma and neurofibroma, which are typically hypointense in T1 and hyperintense in T2 sequences and enhances after gadolinium administration [7]. Tumors that contain melanin are also relevant differential diagnosis, such as melanoma, clear cell sarcoma (malignant melanoma of soft parts), and melanocytic schwannoma, because they can demonstrate high signal intensity on T1WI due to melanin or methemoglobin [12].

Considering the potential of permanent neural damage, early diagnosis and treatment are of key importance in the management of patients with neural endometriosis. Since patients with endometriosis usually undergo pelvic MRI, which is generally reported by a non-musculoskeletal-trained radiologist, abdominal radiologists need to be familiar with the pelvic nerve anatomy and the possible patterns of presentation of neural endometriosis.

**Table 1** Summary of the cases of patients with endometriosis-associated neuropathy

Patient no.	Age (years)	Symptoms	Pelvic endometriosis	Neural involvement	MRI imaging features	Treatment	Outcome
1	31	Pain Impaired motility	No	Sciatic	Infiltrative retractile tissue with hemorrhagic foci	Hormonal treatment physiotherapy	Resolution of symptoms
2	35	Pain Impaired motility	Yes	Sacral plexus	Infiltrative retractile tissue	Surgery amitriptyline	Partial improvement of symptoms
3	50	Pain numbness in vagina; fecal and urinary incontinence	Yes	Pudendal nerve	Infiltrative retractile tissue Thickening of the pudendal nerve	Hormonal treatment physiotherapy	Poor improvement of symptoms
4	38	Pain	Yes	Sciatic	Endometrioma Muscle atrophy	Pregabalin physiotherapy	No improvement
5	31	Pain	Yes	Sciatic and pudendal nerves	Endometrioma	Surgery	Resolution of symptoms
6	32	Pain Impaired motility Sensory loss	No	Sacral plexus	Infiltrative retractile tissue Diffuse thickening and enhancement of the sacral roots	NA	NA
7	48	Pain Impaired motility Sensory loss	Yes	Sciatic	Infiltrative retractile tissue Endometrioma Muscle atrophy	Surgery	Partial improvement of symptoms

NA not available

**Table 2** Summary of current literature of patients with endometriosis-associated neuropathy who underwent MRI

Author (year)	Age (year)	Symptoms	Pelvic endometriosis	Neural involvement	MRI imaging features	Treatment	Outcome
Ceccaroni et al. (2010)	32	Pain Impaired motility Sensory loss	Yes	Sacral plexus pudendal nerve	Endometrioma	Surgery Hormonal treatment	Resolution of symptoms
Descamps et al. (1995)	39	Pain Impaired motility	No	Sciatic	Endometrioma	Surgery Hormonal treatment	Resolution of symptoms
Jeswani et al. (2011)	46	Pain	No	L4 spinal nerve	Endometrioma	Surgery	Resolution of symptoms
Motamedi et al. (2015)	37	Pain Impaired motility	Yes	Sciatic and Lumbosacral plexus	Endometrioma	Hormonal treatment	Resolution of pain Persistence of neurologic symptoms
Possover and Chiantera (2007)	28-37 (28, 37, 32)	Pain	No	Sciatic	Infiltrative retractile tissue	Surgery	Resolution of symptoms
Reddy et al. (2007)	32	Pain Impaired motility	NA	Superior gluteal nerve	Endometrioma	Surgery Hormonal treatment	Partial improvement of symptoms
Siquara de Sousa et al. (2015)	32-49	Pain Impaired motility Sensory loss	No	Sciatic	Infiltrative retractile tissue with hemorrhagic foci	Hormonal treatment	Partial improvement of symptoms
Mannan et al. (2008)	25	Pain Impaired motility Sensory loss	No	Sciatic Lumbosacral plexus	Endometrioma	Surgery	Symptoms considerably relieved
Papapietro et al. (2002)	29	Pain Impaired motility Sensory loss	No	Sciatic	Endometrioma	Surgery Hormonal treatment	Resolution of symptoms
Yekeler et al. (2004)	33	Pain Impaired motility Sensory loss	No	Sciatic	Endometrioma	Hormonal treatment	Resolution of symptoms

NA not available

## Conclusion

Abdominal radiologists need to be aware of pelvic nerve anatomy and the possibility of extragenital endometriosis-associated neuropathy, mainly in patients with cyclic neurological symptoms, even in the absence of genital endometriosis. Early diagnosis may obviate permanent nerve damage and MRI is a reliable tool in the diagnosis of nerve involvement caused by endometriosis.

**Acknowledgments** The authors would like to express their deepest gratitude to Abdalla Youssef Skaf MD, Nucélio Luiz de Barros Moreira Lemos MD, and Luis Pecci Neto MD for providing cases to this manuscript.

**Funding** This research received no funding.

## Compliance with ethical standards

**Conflicts of interest** The authors declare that they have no conflict of interest.

**Ethical approval** This article does not contain any studies with human participants or animals performed by any of the authors. For this type of study formal consent is not required.

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