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CLINICAL ARTICLE

Accuracy of magnetic resonance imaging for diagnosis and preoperative assessment of deeply infiltrating endometriosis

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ABSTRACT

Objective: To evaluate the accuracy of preoperative magnetic resonance imaging (MRI) findings relative to surgical presence of deeply infiltrating endometriosis (DIE). *Methods:* This prospective study included 92 women with clinical suspicion of DIE. The MR images were compared with laparoscopy and pathology findings. Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of MRI for diagnosis of DIE were assessed. *Results:* DIE was confirmed at histopathology in 77 of the 92 patients (83.7%). Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of MRI to diagnose DIE at each of the specific sites evaluated were as follows: retrocervical space (89.4%, 92.3%, 96.7%, 77.4%, 90.2%); rectosigmoid (86.0%, 92.9%, 93.5%, 84.8%, 89.1%); bladder (23.1%, 100%, 100%, 88.8%, 89.1%); ureters (50.0%, 100%, 95.5%, 95.7%); and vagina (72.7%, 100%, 100%, 96.4%, 96.7%). *Conclusion:* MRI demonstrates high accuracy in diagnosing DIE in the retrocervical region, rectosigmoid, bladder, ureters, and vagina.

1. Introduction

Deeply infiltrating endometriosis (DIE) is defined as the presence of invasive endometriotic lesions that extend more than 5 mm from the peritoneal surface into adjacent structures, and is associated with fibrosis and muscular hyperplasia. The condition has gained increased attention from gynecologists, surgeons, and radiologists [1]. An accurate preoperative diagnosis of DIE, including the degree of extension into the pelvic tissues, provides invaluable information to patients and specialist physicians. Comprehensive preoperative counseling and thorough surgical planning have been shown to improve patient outcome (restitution of fertility) and well-being (re-establishment of anatomy leading to lesser or painless states) [2–4].

Diagnostic difficulties posed by the multifaceted presentation of pelvic endometriosis are highlighted by the delayed interval of 7–11 years from the beginning of symptoms to diagnosis [5–7]. Pelvic exams may be reported as normal in up to 40% of evaluations, despite disclosure of painful nodularities in the posterior cul-de-sac [6]. Diagnosis of DIE remains a major challenge in the clinical context and has become an area of focus for pelvic radiologists in the last two decades. Precise preoperative diagnosis of DIE requires radiologists to have meticulous knowledge of pelvic anatomy and the natural history of DIE, as well as expertise in the imaging technique employed prior to surgical and pathologic confirmation. Transvaginal, transrectal, and rectal endoscopic ultrasound used to diagnose DIE have shown variable accuracy depending on the anatomical sites affected and the experience of the investigators [7–10]. Despite noted limitations, magnetic resonance imaging (MRI) remains the best noninvasive method to evaluate the locations affected by pelvic endometriosis [11–15]. However, it has not been possible to generalize the findings of these studies because some were retrospective, others included a small patient cohort, and some included women with a high prevalence of DIE.

There are few data on the diagnostic accuracy of MRI for pelvic endometriosis; in addition, there have been few prospective studies and surveys do not represent all ethnic groups. Moreover, there have been some conflicting results. The aim of the present study was to evaluate the accuracy of MRI findings for the diagnosis of DIE at multiple sites, such as the retrocervical space, rectosigmoid, bladder, ureters, and vagina.

2. Materials and methods

This prospective, observational, cross-sectional study was carried out in women who had a history and findings from a physical exam that were consistent with endometriosis. All women were seen at the

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Serviço de Ambulatório de Endometriose do Departamento de Ginecologia do Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo (HCFMUSP)—a referral center for endometriosis. The study was approved by the Institutional Review Boards of the HCFMUSP and by the Fleury Medicina Diagnóstica, São Paulo, Brazil. All patients gave written consent.

Inclusion criteria were patients who: (a) had a history of symptoms consistent with endometriosis, such as pelvic pain, dysmenorrhea, deep dyspareunia, acyclic pelvic pain, dyschezia, and infertility; (b) had a pelvic examination revealing thickening of the posterior cul-de-sac and/or nodules; (c) had transvaginal ultrasound results showing ovarian cysts with thickened low amplitude echoes; and (d) had had no previous pelvic surgery for endometriosis. All of the patients that were included underwent pelvic MRI before extensive laparoscopic surgery.

Magnetic resonance imaging was performed between November 2005 and July 2007 at the Fleury Medicina Diagnóstica using a GE Signa 1.5 T MRI system (General Electric Medical Systems, Milwaukee, USA). Pelvic MRIs were performed regardless of menstrual cycle phase, which it has been reported does not change the MRI features of DIE. Patients did not undergo bowel preparation, but were instructed to fast for at least 4 hours before the exam. An intravenous line was secured with a 22-gauge BD Insyte-N catheter (Becton Dickinson, Sao Paulo, Brazil) placed into a dorsal vein on each patient's right hand. In addition, 20 mg of hyoscine-N-butylbromide (Buscopan, Boehringer-Ingelheim, Sao Paulo, Brazil) was injected to reduce intestinal peristalsis.

The MRI protocol included axial, sagittal, and coronal fast recovery fast spin-echo (FRFSE) T2-weighted images and axial and sagittal spoiled gradient echo (SPGR) T1 images with and without fat suppression, before and after injection of gadolinium (Dotarem; Guerbet, Aulnay-sous-Bois, France). The imaging parameters were as follows: 5-mm thick sections; field of view 20×24 cm, and a matrix of 256×384 pixels. Each MR examination did not exceed 30 minutes. Additional sequences of magnetic resonance urography (URO-RM), acquired with a coronal 3D SPGR sequence after gadolinium injection, were performed for patients with paracervical lesions measuring 2 cm or more in the distal ureteral path.

Deep pelvic endometriosis was diagnosed according to signal intensity and morphologic abnormalities described by Bazot et al. [12].

MR images were analyzed prospectively by two radiologists (LPC, RB) who were blinded to each patient's history, physical findings, and ultrasound results. The MR findings were recorded as a consensus between the two radiologists.

Sensitivity, specificity, positive and negative predictive values, and accuracy of MRI diagnosis of DIE were evaluated in the retrocervical region, rectosigmoid, bladder, ureters, and vagina with a confidence interval of 95% considering laparoscopic and pathologic findings as the gold standard for diagnosis.

3. Results

Ninety-two women aged 20–52 years (mean age, 33 years) completed the study. The patients had characteristic symptoms at the indicated rates: dysmenorrhea (n=89; 97%); dyspareunia (n=54; 59%); acyclic pain (n=72; 78%); dysuria (n=8; 9%); dyschezia (n=44; 48%); and infertility (n=40; 43%). Most of the patients (n=58, 63%) had palpable nodules that were painful when touched. All 92 patients had laparoscopic and pathologic findings of endometriosis.

MRI was able to accurately detect at least one DIE lesion site in each case. However, only superficial lesions were present in 15 (16%) women. None of these patients had MRI pathologic findings. MRI showed deep-seeded peritoneal lesions without ovarian involvement in 21 (27%) women, and lesions comprising both ovaries and subperitoneal DIE in 52 (68%) women. The distribution of endometriotic lesions according to laparoscopy and histopathology was as follows: peritoneal superficial (n=64); retrocervical space (n=66); rectosigmoid colon (n=50); bladder (n=13); ureters (n=8); and vagina (n=11).

The main signal intensity abnormalities observed were solid nodules with a low T2 signal (similar to that of pelvic muscle) characterized by the presence of fibrosis and predominantly stromal endometrial tissue. The majority of lesions had irregular spiculated margins. Some nodules in the retrocervical region, bladder, and vagina showed a mixed pattern (solid-cystic) due to the presence of cysts inside the lesion with and without hemorrhage.

Data correlating the MRI findings with the surgery and pathology findings at specific sites are detailed below.

3.1. Retrocervical space

Sixty-six out of 77 women (85.7%) had retrocervical DIE (Fig. 1) confirmed by both laparoscopy and pathology (Table 1). Rectosigmoid disease was also diagnosed in 46 of these women. Retrocervical endometriosis was the only DIE lesion in 3 women in this group. Of 61 women showing MR images of the retrocervical space compatible with DIE, only 2 were not diagnosed by laparoscopy (false positives). Pronounced uterine retroflexion caused difficulties in diagnosis in 4

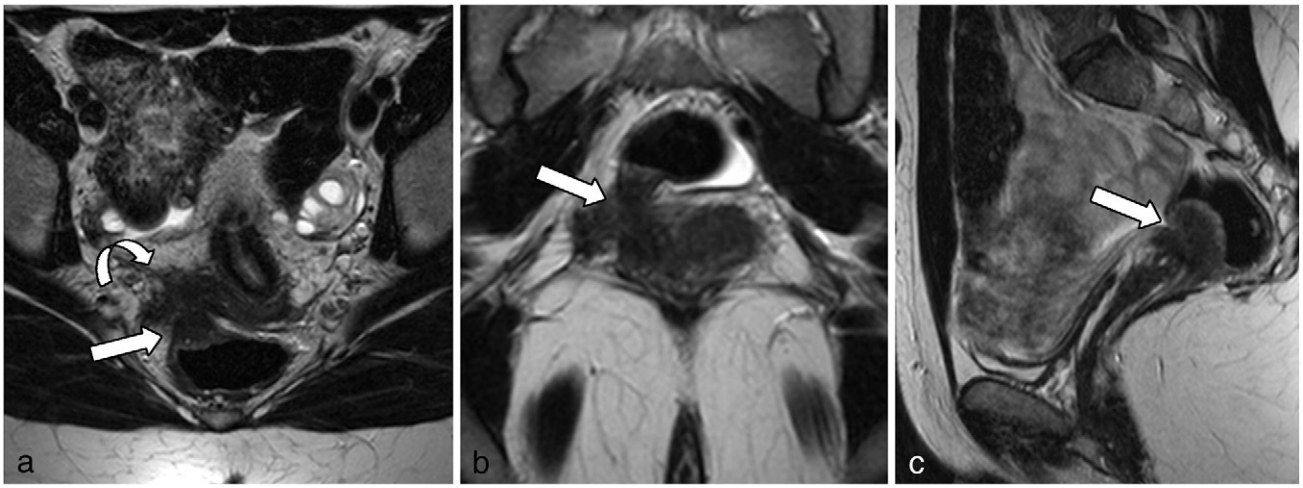

Fig. 1. Transverse (a), coronal (b), and sagittal (c) T2-weighted FRFSE images of a patient with DIE involving the rectum and retrocervical region. (a) Nodule with stellate margins and low signal intensity involves the right uterosacral ligaments (curved arrow). This lesion is attached to another nodule that was infiltrating the anterior rectal wall (straight arrow). Frontal (b) and lateral (c) views of the same lesions (arrows).

Table 1
Agreement between MRI results and laparoscopy and histopathology findings.

MRI diagnosis of DIE	Laparoscopy and histopathology		Total no. of patients	Sensitivity (%)	Specificity (%)	+ PV (%)	– PV (%)	Accuracy (%)
	Presence of DIE (n)	Absence of DIE (n)						
Retrocervical endometriosis								
Positive	59	2	61					
Negative	7	24	31	89.4	92.3	96.7	77.4	90.2
Total	66	26	92					
Rectosigmoid endometriosis								
Positive	43	3	46					
Negative	7	39	46	86.0	92.9	93.5	84.8	89.1
Total	50	42	92					
Bladder endometriosis								
Positive	3	0	3					
Negative	10	79	89	23.1	100	100	88.8	89.1
Total	13	79	92					
Ureteral endometriosis								
Positive	4	0	4					
Negative	4	84	88	50	100	100	95.5	95.7
Total	8	84	92					

Abbreviations: DIE, deeply infiltrating endometriosis; MRI, magnetic resonance imaging; +PV, positive predictive value; –PV negative predictive value.

out of the 7 women who had negative MRI results (false negatives). A large endometrioma (7.3 cm in the largest diameter) located in the posterior cul-de-sac compromised satisfactory MR visualization in another woman. The remaining 2 patients had extensive rectosigmoid lesions in addition to thick adhesions on the posterior uterus.

3.2. Rectosigmoid

The correlations between the MRI findings and laparoscopic and pathology findings of rectosigmoid DIE are summarized in Table 1. DIE was accurately identified by MRI in 43 out of 50 (86%) women (Fig. 2). In 2 women, MR images suggestive of DIE were not confirmed at surgery; and in 1 woman, histopathology revealed fibrosis (false positive). For 7 patients in whom DIE lesions were not suggested by MRI findings, 3 had DIE lesions located in the sigmoid, 2 in the rectosigmoid transition, and the remaining 2 in the midrectum (false negatives).

3.3. Bladder

Surgical and histopathologic diagnosis showed the presence of nodules in 13 women. In one woman, an endometriotic nodule located in the bladder was the only DIE lesion. Five women had DIE in the bladder accompanied by DIE manifestations at other sites. Diagnoses of DIE of the bladder were made by MRI in 3 cases as shown in Table 1.

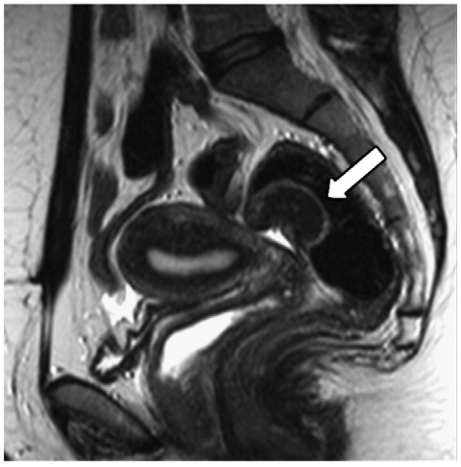

Fig. 2. Sagittal T2-weighted FRFSE image in a patient with a rectal endometriotic lesion, demonstrating a nodule with low signal intensity and a "c" shape located above the peritoneal reflection (arrow).

3.4. Ureters

Correlations between MRI findings and laparoscopy and histopathology findings of DIE of the ureters are summarized in Table 1. The ureters were affected by DIE in 8 women (9%); 4 of these were correctly identified by MRI. One of these 4 women showed involvement of both ureters.

3.5. Vagina

DIE involvement of the vagina was confirmed by laparoscopy and pathology in 11 women. Accurate diagnosis by MRI was made in 8 women (72.7%). In the remaining 81 patients, the absence of vaginal MRI abnormalities was confirmed at surgery. Correlation of MR images with both gold standards showed high sensitivity (72.7%), specificity (100%), positive predictive value (100%), negative predictive value (96.4%), and accuracy (96.7%).

4. Discussion

The present study demonstrates that MRI is accurate in predicting DIE localized in the retrocervical space (90.2%), rectosigmoid colon (89.1%), bladder (89.1%), ureters (95.7%), and vagina (96.7%). These observations confirm and extend the few reports that have been published previously and provide support for the view that MRI has diagnostic value for women suffering from endometriosis associated with pain, infertility, or both [7,11,12,15].

The retrocervical space was the site most often affected by DIE (24%) in the study cohort. This finding corroborates data published by Kinkel et al. (30%), Bazot et al. (35%), and Chapron et al. (83%) [4,11,12]. In the majority of patients, the lesions were located in the uterosacral ligaments and torus uterinus. The most frequently encountered MR aspect was a nodular image with low signal in T2 and spicular contour containing small hemorrhagic cysts. Correlation of MRI findings with laparoscopy and histopathology findings indicated high sensitivity, specificity, and accuracy of MRI. The present data showed superior performance compared with some previously published data [7,12], but not others [11]. Kinkel et al. [11] used a high cut-off value for uterosacral ligament lesions of 0.9 cm or greater, which could explain their superior findings.

The rectosigmoid colon was the second most commonly affected site for DIE in the present study (19%), with most lesions occurring in the rectosigmoid transition, which is similar to results from other

groups [7,11,12]. MRI demonstrates high accuracy in detecting intestinal lesions (89.1%). The pattern of rectosigmoid colon lesions according to MRI was similar in all patients and consistent with other studies [12,16]. Of the 7 intestinal DIE lesions not visualized by MRI, 5 were located in the sigmoid colon. These lesions could have been missed because of the lack of bowel preparation before the exam or increased peristalsis in the segment.

Deeply infiltrating endometriosis of the bladder is uncommon. It is estimated to occur in less than 2% of patients with DIE and is the only site of the disease in 6%–12% of patients [1]. In the present study, only 5% of women had bladder endometriosis identified at laparoscopy. MRI showed low sensitivity, but high specificity, positive predictive value, negative predictive value, and accuracy for bladder lesions. The size of the lesions (1.8–3.0 cm) was the most likely explanation for low sensitivity in this region. However, lesions in plaque, instead of nodules, and low vesical filling could contribute to reduce MRI sensitivity. Balleyguier et al. [13] obtained a much better correlation between preoperative MRI and laparoscopic findings of bladder endometriosis than the present study, diagnosing all the lesions resected at laparoscopy. In the present study, MR images of bladder lesions showed a nodule with low T2 signal that formed an obtuse angle with the posterior wall of the bladder dome.

Ureteral DIE is a rare and severe condition that can result in insidious loss of renal function [17]. Three percent of women showed ureteral DIE confirmed at histopathology. MRI provided correct diagnosis in 50% of these cases with an accuracy of 95.7%. In these women, MR images depicted the site of the lesion and the associated hydronephrosis, but did not disclose any abnormalities in the remaining women. In the false negative cases, the absence of hydronephrosis made the diagnosis more difficult. Few studies have evaluated ureteral DIE, although Balleyguier et al. [14] reported high accuracy. In accordance with the literature, MR images disclosed nodules of low T2 signal intensity with spiculated contours located in the pelvic ureteral path [14].

Vaginal DIE lesions are usually associated with DIE of the posterior cul-de-sac and lower retrocervical region [1]. In the majority of cases, either a nodule or a mass projects itself toward the posterior fornix, causing thickening of the vaginal dome. These lesions are typically heterogeneous with the presence of hemorrhagic cysts [18]. MRI showed high sensitivity, specificity, and accuracy of vaginal DIE.

A few issues that might affect interpretation of the present findings are worth noting. The prevalence of DIE in the study cohort was high because the patients were referred to us from an endometriosis referral center—similar to other studies—thus not permitting extrapolation of the findings to the general population. Furthermore, some of the MRI findings may not have been identified at laparoscopy because they were hidden either in a subperitoneal location or underneath an extensive adhesive process not amenable to laparoscopic surgery. Finally, motion artifacts due to intestinal peristalsis and the presence of intestinal residues may reduce optimal MRI performance.

In conclusion, the present findings indicate that preoperative MRI is an excellent tool to provide a reasonably accurate mapping of multiple sites of pelvic endometriosis. The high accuracy observed across anatomic regions is particularly noteworthy.

References

[1] Clement PB. Diseases of the Peritoneum. In: Kurman RJ, editor. Blaustein's Pathology of the Female Genital Tract. Fifth ed. Baltimore: R.R. Donnelley and Sons; 2002. p. 745–71. Willard OH.

[2] Koninckx PR, Meuleman C, Demeyere S, Lesaffre E, Cornillie FJ. Suggestive evidence that pelvic endometriosis is a progressive disease, whereas deeply infiltrating endometriosis is associated with pelvic pain. Fertil Steril 1991;55(4):759–65.

[3] Chapron C, Dubuisson JB. Laparoscopic treatment of deep endometriosis located on the uterosacral ligaments. Hum Reprod 1996;11(4):868–73.

[4] Chapron C, Fauconnier A, Vieira M, Barakat H, Dousset B, Pansini V, et al. Anatomical distribution of deeply infiltrating endometriosis: surgical implications and proposition for a classification. Hum Reprod 2003;18(1):157–61.

[5] Arruda MS, Petta CA, Abrao MS, Benetti-Pinto CL. Time elapsed from onset of symptoms to diagnosis of endometriosis in a cohort study of Brazilian women. Hum Reprod 2003;18(4):756–9.

[6] Chapron C, Dubuisson JB, Pansini V, Vieira M, Fauconnier A, Barakat H, et al. Routine clinical examination is not sufficient for diagnosing and locating deeply infiltrating endometriosis. J Am Assoc Gynecol Laparosc 2002;9(2):115–9.

[7] Abrao MS, Goncalves MO, Dias Jr JA, Podgaec S, Chamie LP, Blasbalg R. Comparison between clinical examination, transvaginal sonography and magnetic resonance imaging for the diagnosis of deep endometriosis. Hum Reprod 2007;22(12):3092–7.

[8] Abrao MS, Neme RM, Averbach M, Petta CA, Aldrighi JM. Rectal endoscopic ultrasound with a radial probe in the assessment of rectovaginal endometriosis. J Am Assoc Gynecol Laparosc 2004;11(1):50–4.

[9] Bazot M, Malzy P, Cortez A, Roseau G, Amouyal P, Darai E. Accuracy of transvaginal sonography and rectal endoscopic sonography in the diagnosis of deep infiltrating endometriosis. Ultrasound Obstet Gynecol 2007;30(7):994–1001.

[10] Pereira RM, Zanatta A, de Mello Bianchi PH, Chamie LP, Goncalves MO, Serafini PC. Transvaginal ultrasound after bowel preparation to assist surgical planning for bowel endometriosis resection. Int J Gynecol Obstet 2009;104(2):161.

[11] Kinkel K, Chapron C, Balleyguier C, Fritel X, Dubuisson JB, Moreau JF. Magnetic resonance imaging characteristics of deep endometriosis. Hum Reprod 1999;14(4):1080–6.

[12] Bazot M, Darai E, Hourani R, Thomassin I, Cortez A, Uzan S, et al. Deep pelvic endometriosis: MR imaging for diagnosis and prediction of extension of disease. Radiology 2004;232(2):379–89.

[13] Balleyguier C, Chapron C, Dubuisson JB, Kinkel K, Fauconnier A, Vieira M, et al. Comparison of magnetic resonance imaging and transvaginal ultrasonography in diagnosing bladder endometriosis. J Am Assoc Gynecol Laparosc 2002;9(1):15–23.

[14] Balleyguier C, Roupret M, Nguyen T, Kinkel K, Helenon O, Chapron C. Ureteral endometriosis: the role of magnetic resonance imaging. J Am Assoc Gynecol Laparosc 2004;11(4):530–6.

[15] Bazot M, Lafont C, Rouzier R, Roseau G, Thomassin-Naggara I, Darai E. Diagnostic accuracy of physical examination, transvaginal sonography, rectal endoscopic sonography, and magnetic resonance imaging to diagnose deep infiltrating endometriosis. Fertil Steril Nov 17 2008 [Electronic publication ahead of print].

[16] Bis KG, Vrachliotis TG, Agrawal R, Shetty AN, Maximovich A, Hricak H. Pelvic endometriosis: MR imaging spectrum with laparoscopic correlation and diagnostic pitfalls. Radiographics 1997;17(3):639–55.

[17] Yates-Bell AJ, Molland EA, Pryor JP. Endometriosis of the ureter. Br J Urol 1972;44(1):58–67.

[18] Del Frate C, Girometti R, Pittino M, Del Frate G, Bazzocchi M, Zuiani C. Deep retroperitoneal pelvic endometriosis: MR imaging appearance with laparoscopic correlation. Radiographics 2006;26(6):1705–18.