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Pelvic Endometriosis: Spectrum of Magnetic Resonance Imaging Findings

Carla de Venecia, MD, and Susan M. Ascher, MD

Endometriosis is defined as the presence of endometrial tissue outside the uterus. It is a common cause of pelvic pain and infertility among reproductive age women. Although laparoscopy remains the reference standard for diagnosis, this invasive procedure provides little information on subperitoneal extent of disease or areas hidden by adhesions. In contrast, magnetic resonance imaging (MRI) provides a comprehensive, noninvasive survey of the pelvis with simultaneous tissue characterization. In this article, we review the spectrum of MRI findings in pelvic endometriosis and discuss common complications associated with the disease. Radiologists should be familiar with the spectrum of MRI findings of pelvic endometriosis so that they can provide meaningful information that will guide treatment and future laparoscopic examinations.
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Introduction

Endometriosis is defined as the presence of functional endometrial glands and stroma in a location outside the uterine cavity and myometrium. It is a common gynecologic disorder and leading cause of pelvic pain and infertility among women of reproductive age. The estimated prevalence in the United States is 5%-10%. The ectopic endometrium responds to hormonal stimulation with various degrees of cyclic hemorrhaging, resulting in a range of symptoms and often specific imaging features.[1]

Etiology and Pathogenesis

The pathogenesis of endometriosis is unclear and probably multifactorial. Overall, 3 theories of pathogenesis have been proposed: the metastatic theory, the metaplastic theory, and the induction theory.[2] According to the metastatic theory, endometriosis results from metastatic implantation of endometrial tissue from retrograde menstruation. Evidence for this hypothesis comes from the observation that endometriosis occurs with greater frequency in women with obstructive anomalies of müllerian duct development.[3] Other means of metastatic spread include transport of endometrial cells via the bloodstream and lymphatics or iatrogenic spread during needle biopsy and surgery.[4–6]

The metaplastic theory of pathogenesis suggests that peritoneal cells differentiate into functioning endometrial cells as both cell types derive from the same coelomic wall epithelium. The strongest evidence for this theory is the demonstration of endometriosis in men and women who lack functional eutopic endometrium (ie, Turner syndrome, gonadal dysgenesis, or uterine agenesis). Finally, the induction theory combines the first 2 proposed mechanisms and suggests that shed endometrium releases substances that induce undifferentiated mesenchyme to form endometrial tissue.[7]

Three Forms of Pelvic Endometriosis

There are 3 distinct forms of pelvic endometriosis: superficial peritoneal implants, endometriomas, and deep pelvic endometriosis.[1,8]

Superficial peritoneal implants are well recognized at laparoscopy as black, white, or red, depending on the degree of fibrosis, scarring, and hemorrhage in the lesion.[9] On gross pathology, endometriotic implants vary in size from punctate foci to small stellate patches less than 2 cm. Implants change during the menstrual cycle, enlarging and then bleeding during menses. These mature endometriotic implants initiate an inflammatory response, which in turn causes organized hemorrhage, fibrosis, and adhesion formation. Extensive adhesions can distort the normal pelvic anatomy and may

Department of Radiology, MedStar Georgetown University Medical Center, Washington, DC.
Address reprint requests to Susan M. Ascher, MD, Department of Radiology, MedStar Georgetown University Medical Center, 3800 Reservoir Rd, NW, Washington, DC 20007. E-mail: aschers@gunet.georgetown.edu

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Table MR Imaging Protocol for Pelvic Endometriosis

Sequence	Plane	Slice Thickness (mm)
T2W SSFSE	Axial, sagittal	5
T1W spoiled GRE without and with chemically selective FS	Axial	3-6
Diffusion-weighted imaging	Axial	5-6
T2W 2D TSE high resolution*	Axial, sagittal	4
Precontrast T1W volume interpolated GRE FS	Axial, sagittal	2
Precontrast T1W volume interpolated GRE test bolus	Axial	2
Postcontrast dynamic T1W volume interpolated GRE ×3 runs	Axial	2
Postcontrast T1W volume interpolated GRE FS of pelvis	Sagittal	2

FS, fat suppression; GRE, gradient echo; SSFSE, single-shot fast spin echo; T1W, T1 weighted; T2W, T2 weighted; TSE, turbo spin echo.
*T2W 3D TSE may be substituted for sagittal T2W 2D TSE sequence.

obliterate anatomical spaces. The most common site of involvement is the ovary, but all pelvic organs can be affected.[7] Small nonhemorrhagic superficial peritoneal implants are often not detectable with magnetic resonance imaging (MRI).[10,11]

The second form of pelvic endometriosis is the ovarian endometrioma. Endometriomas are endometriotic cysts that occur in the ovaries because of repeated cyclic hemorrhage in a deep implant. Endometriomas may completely replace the normal ovary. The cysts can be thick walled and are typically composed of degenerated blood products, lending the name "chocolate cyst." Endometriomas are bilateral in approximately 50% of cases and may be large, measuring up to 15 cm in diameter. Large lesions and those complicated by wall nodularity should be carefully evaluated to exclude malignancy.[7]

The third form of pelvic endometriosis is deep pelvic endometriosis, defined as subperitoneal invasion of endometrial tissue by at least 5 mm.[2] On microscopic examination, deep pelvic endometriosis is characterized by fibromuscular hyperplasia surrounding scant ectopic endometrial glands. The ectopic endometrial tissue responds to hormonal stimulation with cyclic hemorrhaging, resulting in inflammation and fibrotic reaction. At times, deep pelvic

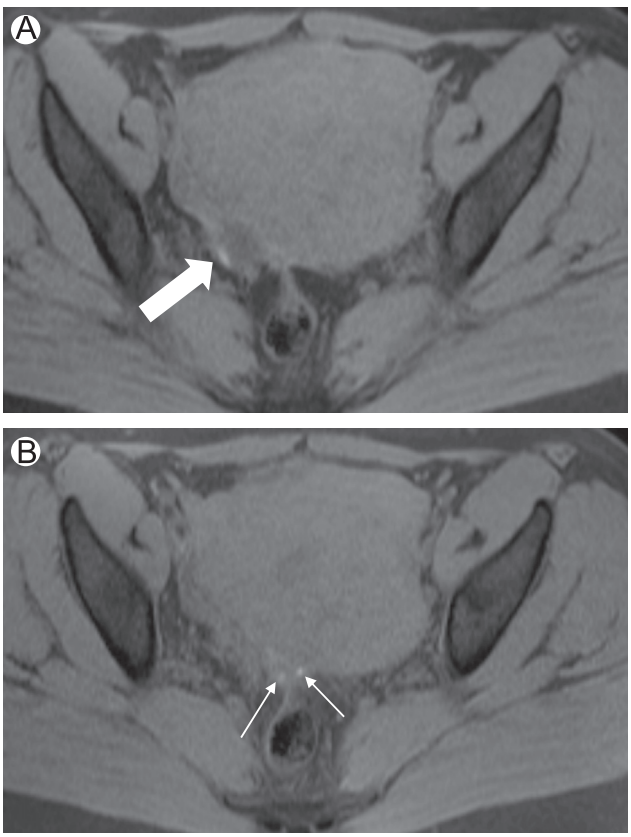

Figure 1 Superficial peritoneal implants in 45-year-old woman with fibroids. (A) Axial T1-weighted imaging with fat suppresion demonstrates hyperintense focus along right ovary (thick arrow) and (B) multiple hyperintense foci in rectouterine pouch (thin arrows). These findings are consistent with superficial peritoneal impants.

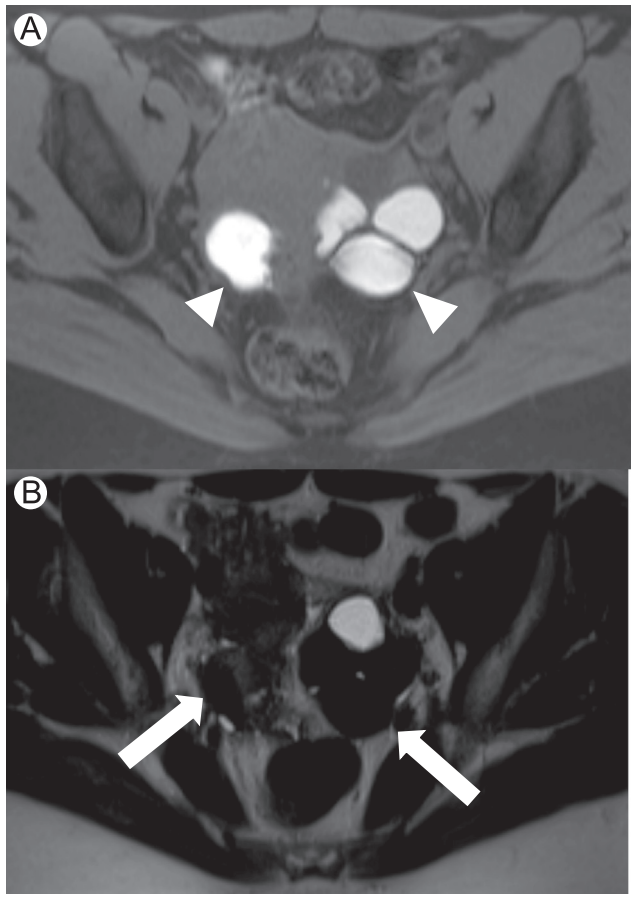

Figure 2 Bilateral endometriomas in 32-year-old woman with complex adnexal cysts on ultrasound. (A) Axial T1-weighted imaging with fat suppresion demonstrates multiple hyperintense bilateral adnexal lesions (arrowheads). (B) Adnexal lesions demonstrate "shading" on T2-weighted imaging (arrows).