MR Imaging of endometriosis: A pictorial review.


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Abstract: Endometriosis is the presence of endometrial tissue outside the uterine cavity(1-3). This endometrial tissue may be located in the ovaries as endometriomas and/or as extraperitoneal/subperitoneal implants(3,4). When implant depth is greater than 5 mm, condition is referred to as deep endometriosis(2,4). It represents a common cause of pelvic pain and infertility in young women(1-3). Surgery remains the best treatment option, so pre-operative evaluation to assess the extent of disease is essential(3,4).

Magnetic resonance imaging (MRI) is a non-invasive, non-ionizing radiation method, offering high contrast resolution, which allows multiplanar evaluation of endometriosis, thus facilitating a correct diagnosis and appropriate treatment(2-4). Radiologists have to be familiar with MR imaging appearance of endometriosis, in order to guide clinicians and provide adequate information to assure accurate diagnosis and timely treatment of this entity.

Key words: Endometriosis, MRI.

Resumen: La endometriosis es la presencia de tejido endometrial fuera de la cavidad uterina(1-3). El tejido endometrial puede localizarse en los ovarios como endometriomas y/o como implantes a nivel subperitoneal o extraperitoneal(3,4). Cuando estos implantes son mayores a 5 mm de profundidad, se denomina endometriosis profunda(2,4). Es una causa frecuente de alergia pélvica e infertilidad en mujeres jóvenes(1-3). La cirugía sigue siendo la mejor opción terapéutica por lo que la valoración preoperatoria de la extensión de la enfermedad es fundamental(3,4).

La resonancia magnética (RM) es un método no invasivo, sin el uso de radiación ionizante y con alta resolución de contraste, que permite la evaluación multiplanar de la endometriosis, facilitando así el diagnóstico correcto y el tratamiento adecuado(2-4). Los radiólogos deben estar familiarizados con los hallazgos de imagen de RM de la endometriosis, a fin orientar al clínico y proporcionar información adecuada para el diagnóstico y tratamiento de esta patología.

Palabras clave: Endometriosis, RM.


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Introduction

Endometriosis is the presence of endometrial tissue outside the uterine cavity. It is an estrogen-dependent disease that affects 5-20% of women of reproductive age(1-3). It manifests as dyspareunia, dysmenorrhea and infertility, although it may be asymptomatic(1,3,4).

The ectopic endometrial tissue can be located in the ovaries as endometriomas and/or as sub peritoneal level implants in the rectovaginal septum, in the uterosacral ligament, broad ligament, gastrointestinal tract, urinary tract and other extraperitoneal sites such as the abdominal wall(3-4) (Figure 1). When these implants are at a greater depth than 5 mm it is known as deep endometriosis(3,4).

Etiology and pathogenesis

The etiology is multifactorial, several theories exist. Retrograde menstruation is the most accepted, with transportation of endometrial tissue from the uterine cavity into the peritoneum through the tubes(1-3).

A second theory suggests that the Mesenchymal cells present on the serosal surfaces (coelomic epithelium) or remnant Müllerian tissue can be differentiated into endometrial cells(1-3).

A third theory is the induction, which is a combination of the other two theories. It suggests that the endometrium secretes substances that induce undifferentiated mesenchyme to form endometrial tissue(1-3).
Figure 1. Main locations of Endometriosis. (1) Ovarian endometrioma, (2) Adhesions at the base of the Pouch of Douglas, (3) Rectosigmoid, (4) Adhesions in the vesicouterine space, (5) rectovaginal septum, (6) Urinary Bladder and (7) abdominal wall.

### Diagnosis and evaluation techniques

The evaluation and diagnosis of endometriosis are limited to physical examination\(^3\text{-}^5\). Laparoscopy is the standard technique for the diagnosis of endometriosis\(^4\text{-}^5\), as the brown or black nodular lesions on peritoneal surfaces are pathognomonic\(^5\), however, it does not display the occult adhered lesions and identify the atypical lesions (unpigmented)\(^5\). Ultrasound is usually the first and most commonly used imaging for the evaluation of patients with pelvic symptoms and infertility\(^5\). It is a good method for the detection of adnexal masses with the appearance of endometriomas\(^2\text{-}^5\), however, it cannot differentiate some endometriomas from hemorrhagic cysts or other ovarian neoplasms and is not sensitive in the detection of peritoneal implants\(^2\text{-}^5\). Magnetic resonance imaging (MRI) is a noninvasive imaging technique, without the use of ionizing radiation or iodinated contrast agents\(^3\). The MRI is an excellent method for identifying old hemorrhagic content that characterizes the endometriomas\(^3\) and allows the identification of the sub-peritoneal implants and implants hidden by adhesions because of its large field of vision, multiplanar capability and high spatial resolution\(^6\text{-}^9\). It has been estimated that the sensitivity, specificity and accuracy is 90%, 98% and 96%, respectively, for the diagnosis of endometriomas and the differentiation of other gynecological masses\(^5\).

### MRI technique

#### Patient Preparation

The images are obtained independently of the menstrual cycle, the patient must have fasted for at least 4-6 hours and refrain from urinating for 1 hour before the test. This corrects the uterine anteversion angle and displaces the small intestine cephalad. The day before the test bowel cleansing can be done with an oral laxative. In most cases 50-60ml of endovaginal ultrasound gel is applied to distend the vaginal cavity and allow better evaluation of the retrocervical area and vaginal fornix. Only apply 60 ml of endorectal ultrasound gel in cases of suspected rectal involvement.

In those cases where the first images show degradation by intestinal peristaltis artifacts, it is recommended to inject 10 mg Buscopan intravenously.

### Imaging characteristics of endometriosis

The main manifestations of endometriosis are hemorrhagic ovarian cysts (endometriomas), fibrotic nodules and sub-peritoneal adhesions and in other locations\(^1\text{-}^3\), each of which has characteristics in MR which are detailed following, grouping the main findings in: (A) Ovarian endometriomas (B) Deep pelvic endometriosis and (C) Deep extraperitoneal endometriosis.

#### A. Endometriomas

Endometriomas are cysts that occur in the ovaries, the result of repeated cyclic hemorrhage. They have thick walls and the content is dark degenerated blood products. This appearance has been called “chocolate cyst”\(^2\text{-}^4\). They are bilateral in up to half of the cases. Although the cysts are usually large, they rarely exceed 15 cm in diameter\(^2\text{-}^4\).

The ovarian endometriomas (Case No. 1), are typically hyperintense on T1-weighted sequences\(^2\text{-}^5\). This hyperintensity is most obvious on T1-weighted images taken with fat suppression, by eliminating the high signal from surrounding fat, thereby increasing the sensitivity for detection of small foci of endometriosis\(^2\text{-}^5\). While in T2-weighted sequences they are hypointense, an effect called “shading”\(^3\text{-}^5\), which is explained by the presence of blood in various stages\(^2\text{-}^4\). The use of gadolinium can show a nonspecific and variable enhancement pattern that does not differentiate it from other benign and malignant processes\(^2\).

#### B. Deep peritoneal endometriosis

Deep endometriosis corresponds to implants at a depth of more than 5 mm.

Unlike endometriomas, deep endometriosis implants may have different characteristics on the MR image. Most of these are hypointense on T2-weighted sequences as well as on T1\(^1\text{-}^3\). This hypointensity is due to a desmoplastic reaction with fibromuscular proliferation\(^1\text{-}^3\). They
have poorly defined borders with infiltrative appearance, causing retraction of organs or surrounding structures\(^1\-\(^3\). The presence of hemorrhagic foci, hyperintense on T1 sequences with and without fat suppression, is a very characteristic MRI finding for endometriotic implants, but is seen less often in deep implants than in adnexal lesions\(^1\-\(^3\).

![Figure 2. Compartments of the pelvis. Anterior: Virtual space located between the anterior face of the uterus and posterior wall of the bladder, including urinary bladder, urethra, vesicouterine pouch and vesicovaginal septum. Middle: Between the anterior and posterior compartment, including the uterus, fallopian tubes, ovaries and broad ligament. Posterior: Virtual space located between the posterior vaginal wall and the anterior rectal wall, affects the rectovaginal septum, uterosacral ligaments, uterine torus, pouch of Douglas and rectosigmoid.](image)

Case Nº. 1. 37 year old woman with a history of dysmenorrhea. Images: (a) coronal T2-weighted and (b) axial T1 with fat suppression and gadolinium. Enlarged right ovary with multiple cysts (*) and an endometrioma with intermediate signal on T2 and hyperintense on T1 with fat suppression and gadolinium (à black

Implants can be enhanced with gadolinium, however this feature is neither sensitive nor specific\(^2\).

Implants at the pelvic level can be classified according to the affected compartment\(^3\) (Figure 2).

**Classification of deep endometriosis according to pelvic location.**

**B. 1. Anterior Compartment**

This compartment includes implants that are located in the vesicouterine pouch, vesicovaginal septum, bladder (detrusor muscle) and ureter\(^3\).

These lesions are less frequent and up to 75% are associated with lesions from other compartments\(^3\). Endometriosis of the urinary tract occurs in approximately 20% of cases and the bladder is the organ most frequently affected\(^4\), followed by ureters\(^2\). When there is bladder involvement, endometriotic implants are often confined to the serosal surface, however they can also infiltrate the muscular layer and project into the lumen\(^3\). In most cases, the lumen implants are iatrogenic in relation to pelvic surgery\(^3\). These may manifest clinically as cyclic hematuria (Case 2).

In ureteral involvement (Case No. 3) endometriotic tissue is implanted into the ureteral adventitia, the direct invasion of the ureter may induce hyperplasia and fibrosis of the muscle itself, resulting in luminal narrowing\(^2\-\(^3\). This may manifest as hydroureteronephrosis and in more severe cases, as kidney failure\(^3\). The impairment of renal function can be observed in up to 30% of these cases\(^3\).

**B. 2. Middle compartment**

The middle compartment contains the female genital organs such as the ovaries, fallopian tubes, uterus and vagina. It also includes the broad ligaments that are peritoneal folds between the uterus and the sidewalls of the pelvis and the round ligaments of the uterus\(^3\). The most common affection in this compartment is at the level of the ovaries as endometriomas, as discussed above, but
Case Nº 2. 53 year old woman. Background history of hysterectomy with cyclic hematuria. Images: (a) Sagittal T2-weighted, (b) coronal T2, (c) axial T2 and (d) Cystoscopy. On the bladder roof at left (à white) a mass of 1.5 x 1.1 cm can be seen, this is an intermediate T2 signal with undefined borders infiltrating the bladder wall, being located in the bladder lumen (à black). In the cystoscopy can be observed, in left top wall, a sessile uplifted lesion of approximately 1 cm. The remainder of the bladder mucosa appears normal and without lesions.
Case No. 3. 31 year old woman with a history of dysmenorrhea. Images: (a) coronal T2-weighted (b) axial T1 and (c) coronal T2. Left ovarian endometrioma (à white) of 9.3 x 7.6 cm attached to the uterine torus by a deep endometriosis foci (à white curved). Infiltration of the distal ureter by fibrotic endometrial implant (à) that is associated with hydroureteronephrosis (*).

can also be observed as fibrotic implants in the ovaries\(^3\).

Uterine ligaments (broad and round ligaments of the uterus) may be affected, showing thickening and nodularity of these structures\(^3,4\).

The involvement of the fallopian tubes usually occurs in the sub-serous layer\(^3\) and is strongly associated with infertility\(^3\) (Case 4).

**B. 3. Posterior compartment**

Virtual space located between the posterior wall of the cervix-vagina and anterior rectal wall, including the rectovaginal septum, uterosacral ligaments, uterine torus, pouch of Douglas and rectosigmoid\(^3\).

This is the most common location, the retrocervical pouch and uterine torus (which corresponds to the reflection of the peritoneum on the fundus of the uterus) being the most affected sites\(^3\). Usually produces peritoneal adhesions and retraction of the ovaries toward the posterior-middle area locating adjacent to each other, radiological sign known as “kissing ovaries”\(^6\) (Case No. 5).

The gastrointestinal tract may be compromised in 12-37% of patients with endometriosis\(^2-4\). It most commonly affects bowel segments in the dependent portion of the pelvis and is rarely found proximal to the terminal ileum\(^2\).

The most commonly affected areas in decreasing order of frequency are the sigmoid colon, appendix, cecum and distal ileum\(^2\). Implants are usually located on the serosal surface, but may eventually erode the subserosal layers and cause marked thickening and fibrosis of the muscularis propria until finally invading the mucosa\(^2-4\).

The invasion of the sigmoid colon or rectum can cause rectal catamenial and changes in bowel habits. In cases of rectal invasion, these can adopt a morphology described in literature as a “mushroom cap sign”\(^7\) (Case No. 6).

**C. Extraperitoneal Endometriosis**

Corresponds to all implants located outside the peritoneal cavity. Implants have been described in the thoracic cavity, the abdominal and pelvic walls\(^2\).

The abdominal wall is the most common site of extraperitoneal endometriosis. The majority of implants are
Case N° 5. 32 year old woman. History of dysmenorrhea and infertility. Images: (a) coronal T2-weighted, (b) axial T1, (c) graphic image of b and (d) sagittal T2. Enlarged ovaries with endometriomas (à black) and cysts. These are located adjacent to each other, sign known as "kissing ovaries." Deep fibrous endometriosis in the pouch of Douglas with adhesion of the uterus - rectosigmoid junction and ovaries (à white).

Case N° 6. 34 year old woman. History of rectal bleeding associated with menstruation. Images: (a) Sagittal T2 weighted and (b) graphic image of endometrial implant invading the rectal walls. Deep fibrous Endometriosis in fundus of the uterus invading the rectal wall, with "Mushroom cap sign", hypointense on T2 (à black).
located near scars of previous cesarean sections\textsuperscript{15} (Case No. 7). These implants can be located at muscle level, subcutaneous or both.

MR characteristics are variable but the majority are iso- or hypointense on T1 and T2\textsuperscript{16}.

Another location is the episiotomy site (Case No. 8). It may manifest with a palpable nodule in the perianal region with cyclical changes of size\textsuperscript{8}.

**Case No. 7.** 46 year old woman. Nodule of the abdominal wall under study. Images: (a) sagittal T2-weighted and (b) axial T1 and (c) axial T1 with fat-suppression and gadolinium. Solid node 20 x 12mm on abdominal wall at the hypogastrium level lateralized to the left, heterogeneous signal (with hypointense foci) on T2 and isointense on T1 (white circle) with discrete and homogeneous enhancement with contrast. External marker (*). Pathology compatible with endometriosis foci.

**Case No. 8.** 33 year old woman. Palpable nodule in relation to episiotomy. Images: (a) axial T2-weighted and (b) axial T1. Lobulated nodule in the right perianal region on episiotomy site (white). Slightly hyperintense on T1 and isointense on T2.
Conclusion
Endometriosis is a common cause of pelvic pain and infertility in young women\(^1\)\(^-\)\(^3\). Surgery remains the best treatment option\(^3\)\(^,\)\(^4\). Successful treatment requires the removal of the lesion by radical surgery. The accurate preoperative assessment of the extent of the disease is extremely important\(^3\)\(^,\)\(^4\). Physical examination alone does not provide adequate preoperative information\(^3\)\(^,\)\(^4\).

Ultrasound is the most widely used imaging technique with suspected endometriosis, but is nonspecific and is limited to the evaluation of endometriomas\(^2\)\(^-\)\(^5\). By contrast, MRI provides a more accurate and specific diagnosis of endometriomas, and a better characterization of deep endometriosis, showing morphology and altered signal characteristics. MRI is also able to evaluate lesions hidden by dense adhesions, which are not visible in laparoscopy\(^2\)\(^-\)\(^4\). Radiologists must be familiar with the MR imaging findings of endometriosis, to guide and provide adequate information for the diagnosis and treatment of this condition.

References