Endometriosis: Different locations and faces seen by CT and MRI

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Learning objectives

- Review by CT and MRI the different locations and radiological faces of pelvic and extrapelvic endometriosis (including ileal, diaphragmatic dome, suprarrenal gland and lung) as a tool to approach a more specific diagnosis.

- Review and updating of the epidemiology, clinical and treatment of endometriosis.

Background

The endometriosis is a chronic inflammatory disease defined how the presence of functional endometrial glands and stroma outside the uterine cavity (ectopic tissue). [1,2,3] The ectopic endometrium is influence by female hormones during the menstrual cycle.

The ectopic endometrial tissue is most commonly located in the ovaries as endometriomas (20-40% of cases) [2] and the pelvic peritoneum. Others locations less affected, includes the subperitoneal space where mainly observed lesions that penetrate at least 5 milimeters depth the retroperitoneal space or the wall of pelvic organs (rectovaginal septum, uterosacral ligaments, vagina, gastrointestinal and urinary tract and others extraperitoneal pelvic sites) also called deep infiltrating endometriosis, that is associated with fibrosis and muscular hyperplasia [2,5,6]. The extrapelvic organs can be affected as diaphragmatic dome, suprarrenal gland, lung, pleura, brain and skin [1].

The gold standard for the diagnosis of endometriosis is the laparoscopic surgery [1,2,3,6,8] but it’s use is currently limited. Nowadays, the CT and MR preoperative images helps to precise the location and extension of the ectopic tissue, showing the different radiological faces and improving identification, therapeutic procedure type and treatment planning.

Findings and procedure details

Epidemiology.
The prevalence of this disease is difficult to clarify, but it is approximately 0.5-5% in fertile women and 25-40% in sterile women [8]. The mean age of presentation is 25 to 29 years old [1], and the most common symptoms are the infertility (25-50%) and the chronic pelvic pain (90%) [2].

**Faces of endometriosis on CT and MRI.**

We explain the pelvic and extrapelvic endometriosis visualized by CT and MRI in three faces of presentation: 1) ovarian endometriosis, 2) endometriotic implants and 3) inflammatory changes and fibrosis peritoneal, extraperitoneal and extrapelvic.

- **Ovarian endometriosis**

The ovarian endometriosis also called endometriomas are bilateral in the 50% of the cases and affects partially or totally the ovary modifying its normal tissue by ectopic tissue [1]. In the CT imaging can be seen as normal or enlarged size ovaries (image 1), mild or moderate ovarian wall thickening (image 2, 3) or unique ovarian cystic without or with fine or thick septa inside with homogeneous content (image 3); or multiple small cysts (image 1, 2). In addition, by 15% they may be heterogeneous cysts with high density content suggesting clots or blood count [9] (image 7b), enhancing soft-tissue mass with irregular margins or heterogeneous masses (image 3, 7a) that simulate the presence of adnexal tumors. Although uncommon calcifications may also exist (image 2b). CT findings of endometriomas are nonspecific [9].

MR imaging has been shown a high specificity (98%) for the diagnosis of endometriomas [1]. They are homogeneous and show high signal intensity on T1-weighted images (image 8a, 9a) [1,3]. In a T1-weighted fat-suppressed sequences the hiperintensity lesion will highlight more by the supression of surrounding fat (image 8b, 9b) and therefore more sensitive in the detection of small lesions and more specific eliminating fat containing lesions such as dermoids tumors and mature cystic teratoma [3].

When the lesion contains degenerated blood products appear with high signal intensity areas on T1-weighted images and T2-weighted images, and in the endometriosis the recurrent bleeding within of the lesion is common. A important finding on T2-weighted image with the endometrioma is loss of signal within the lesion "shading sign" (image 8c,d; 9 c,d) [1] and is present when the lesion is hyperintense on T1-weighted images and becomes hypointense on T2 weighted images or "mixed aspect" [1]. This sign helped establish a diagnosis of endometrioma with specificity greater than 90% [3].
Endometriotic implants and inflammatory changes/fibrosis peritoneal, extraperitoneal and extrapelvic.

The endometriotic implants and inflammatory changes/fibrosis seen by CT are nonspecific, but help in the location of lesion and should be suspected when the image shows hypodense or hyperdense solid nodular lesions (more frequent), thickening of soft tissues, such as: irregular, spiculated, laminar or linear; parametrial infiltration (image 4d) and adjacent stranding fat pelvic structures (image 3, 4, 7c). Adhesions with different morphologies: linear or irregular that extends from one organ to another and that modifies the normal pelvic morphology and the adjacent organs, causing stenosis (image 5, 7a), disfigurement or shortening [9].

In the case of gastrointestinal tract the findings could be: extrinsic mass effect, spiculation mass, flattening lesions or circumferential narrowing, short thickening of intestinal wall (image 6). Less common anular lesion, plaque-like lesions or intraluminal polipoid mass. The initial debut of intestinal endometriosis can be with a mechanical bowel obstruction (image 6) [4].

On MR imaging the deeply infiltrating endometriosis may have a different presentations. Most are fibrous tissue (acellular regions) and smooth muscle proliferation with low signal intensity lesions on T1-weighted images and T2-weighted images [5]. The lesions can be solid endometriotic masses or nodules, adhesions with irregular, stellate, speculated margins (image 10, 11) [1]. Also irregular soft-tissue masses thickened (image 11). When have involvement ligaments show assymetryc hypointense thickening and nodules within the ligaments.

When in this sites have dilated ectopic endometrial glands and bleeding foci the MRI image show hyperintense T2-weighted images and T1-weighted images or even greater with fat-suppressed T1-weighted (image 12) [5].

For explain better the endometriotic implants in the pelvis can be classified in three compartments: anterior, middle and posterior [5,6].

ANTERIOR COMPARTMENT.

Include the presence of endometriotic implants within the vesicouterine pouch, vesicovaginal septum, bladder (detrusor muscle) and ureter. 50-75% are associated with lesions in other pelvic sites [5,6]. The involvement of the bladder and de uréter (6.4%) indicated an advanced stage of endometriosis.
- **Bladder**: most affected organ of the urinary tract, about 20% of cases [1,5,6], mainly affect the serosa surface showing a extrinsic mass, but can infiltrate the muscle detrusor and show mural mass that project into the lumen (image 13 a,b) [2,5]. In MRI can see abnormal morphology, in T2-weighted images show localized or diffuse hypointense thickening wall vesical (image 13). The lesion in the muscle detrusor with contrast is more enhanced than the normal muscle [2].

- **Ureter**: is affected by extrinsic involvement of bladder or another pelvic organ. The endometrial tissue can infiltrate the muscularis propria, lamina propria or ureteral lumen [2,6].

**MIDDLE COMPARTMENT.**

Includes involvement of ovaries (previously explained), vagina (14.5%), fallopian tubes, uterine serosa and uterine ligaments.

- **Fallopian tubes** on CT imaging can manifest with the presence of tortuous or dilated tubular structures (image 1), homogeneous or heterogeneous content and thickening walls [1,3]. In MRI, often the only finding of endometriotic implants is the presence of hiperintensity within a dilated structures on T1-weighted images (image 9) (40%) [3]. The shading sign in the fallopian tube (image 14) is very rare in association with endometriomas. Also can see peritubal adhesions and tubal obstruction due to recurrent hemorrhage causing infertility[1,5,3].

- **Vagina**: is associated with retrocervical and rectal endometriosis. In T2-weighted MRI appears as hypointense polypoid or nodular masses involving the posterior vaginal fornix or thickening of the wall vaginal, mainly the superior one-third of the posterior wall [2].

**POSTERIOR COMPARTMENT.**

Involvement of the rectovaginal pouch, retrocervical area-torus uterinus, uterosacral ligaments, pouch of Douglas, posterior vaginal fornix, rectovaginal septum and rectum-sigma. The places more affected by endometrotic implants are rectovaginal septum and uterosacral ligaments (69.2%).

- **Uterosacral ligaments**: the findings in MRI are usually subtle. The portion more affected is the proximal medial. The lesions may be nodular unilateral or bilateral lesions.

- **Retrocervical region**: associated with lesions in vagina and bowel [3]. In this place are frequent the peritoneal adhesions and posteroentral shrinkage of the ovaries being
located adjacent to each other, radiological sign called *kissing ovaries* (images 9, 15) [5].

- **Rectovaginal space**: the lesions in this site are frequently extensions from retrocervical or posterior vaginal lesions and in MRI are hypointense. Its important know if the lesion have infiltrated the anterior rectal wall (images 10, 11, 12) [2].

- **Rectosigmoid**: is the major site of gastrointestinal involvement by 85%. [1-6]. Mainly involves serosal but can extense and cause thickening and fibrosis of the muscularis propria. Mostly, the rectal mucose is intact. This type of endometriosis is usually misininterpreted as cancer or Crohn disease [7]. A specific finding of rectosigmoid endometriosis is *"mushroom cap sign"* (image 16, 17, 18). This sign in MRI showed hyperintense on T2-weighted images in the mucosal and submucosal layers (outer covering of the mushroom) which are displaced into the bowel lumen [3] and heterogeneous hypointense on T2-weighted images in the hypertrophic muscularis propria (central pattern radiated, within the mushroom) [5,7]. This sign in MRI is important for diagnosis of deep rectosigmoid endometriosis.

Endometriosis can also affect other sites of gastrointestinal tract as the appendix, ileal (1-7%), cecum and descending colon of greater to minor frequency [1-2]. The endometriotic lesion is a solid, homogeneous nodule with irregular margins that arise of the wall intestinal with low signal intensity at T2-weighted MR images (image 19) [2].

The *extrapelvic endometriosis* is rare, but may be present in the diaphragmatic dome (image 20), suprarrenal gland (image 21), lung (image 22) and brain or skin.

**Treatment**

Patients with infertility or chronic pelvic pain with diagnosis of endometriosis are usually treated surgically. The treatment of choice for endometriosis is laparoscopic resection of all endometriotic tissue (ovarian endometriomas, peritoneal implants and adhesions) and may enhance fertility [2,10].

In the medical therapy MRI can be monitor response to treatment with hormonal therapy. One study found that shading on T2-weighted images is the most important negative predictor of volume reduction suggest that hormonal therapy should be discontinued when shading is observed in endometriomas after initial medication, and the lesions henceforth should be treated with surgical therapy [10].
Fig. 1: Women of 45 years with dysmenorrhea. Coronal CT image showing enlarged ovaries. Adjacent to ovaries observed a dilated tubular structures of liquid density and adjacent mild fat stranding, corresponding to the fallopian tubes dilated (red arrows). The diagnosis was endometriomas and endometriosis of fallopian tubes confirmed by histology biopsy of the resected lesions.
Fig. 2: Women of 46 years with history of cesarean 5 years ago and abdominal pain, dysmenorrhea, constipation and weight loss. (a,b) Axial CT image showing enlarged ovaries (OD: 35mm, OI: 60mm) with mild thickened wall and bilateral multiple small cysts inside (b) presence of calcification within the right ovary.
**Fig. 3:** Women of 30 years old with abdominal pain with menses, constipation and dysmenorrhea by endometriomas and endometriotic implants in rectovaginal region. (a,b) Axial and coronal CT images a venous phase showing a unique cyst lesion with a slight thickened and irregular wall in the portion anteriomedial of the right ovary (red arrow); and the left ovary show a dense nodular lesion with irregular margins (white arrow) in contact with (c,d) uterus and rectosigmoid region conditioning luminal stenosis (white arrow).
Fig. 4: Women of 41 years with abdominal pain and metrorragias with endometriosis in the ovaries, rectovaginal septum and parametria (a,b) Axial CT venous phase image showing a irregular thickening of septum rectovaginal (white arrows) and adjacent fat stranding of cervix and uterus (black arrows), c) Coronal CT image d) and thickened of parametria (red arrow).
**Fig. 5:** Women of 39 years with diagnosis of bilateral endometriosis and deep infiltrating endometriosis. (a,b) Coronal and sagittal CT images with venous phase showing fibrotic changes as lineal adhesion (red arrow) and adjacent fat stranding originating from the right ovary and extends to inferior face of sigma.
**Fig. 6:** Women of 46 years with diagnosis of bilateral endometriomas. In emergency department the patient begins with pain abdominal, diarrhea and nausea, which consisted of acute intestinal obstruction; the definitive diagnosis was ileal endometriosis and confirmed by histology of the resected lesions. (a,b,c) Axial, Coronal and Sagittal CT images showing significant generalized distension of bowel loops with a change of caliber at the distal ileum where a short enhanced thickening (25mm) from the wall (red circle) causing occlusive stenosis with acute intestinal obstruction. With these findings several differential diagnoses among which were inflammatory bowel disease or neoplastic process was.
**Fig. 7:** Women of 42 years with a strong pelvic pain and diagnosis of pelvic endometriosis. (a) Axial CT image with venous phase shows large left cyst lesion with thin septa inside, (b) with a subtle component hyperdense (hematic component, black arrowhead) occupying the left lower hemiabdomen that corresponding to left endometrioma. (c) Also, a pseudonodular lesion (red arrow in a) in the right anexial region that may correspond to right ovary and infiltrate the sigma and mesenteric fat stranding (black arrow) that corresponds to extensive endometriosis.
**Fig. 8:** Women of 37 years with pelvic chronic pain and infertility with right endometrioma with classic MRI features. (a) Axial T1-weighted MR image shows in the right ovary a hyperintense and homogeneous cystic lesion (red arrow), (b) Axial Fat-suppressed T1-weighted MR image shows a same cystic lesion with more intensity (red arrow), (c) Axial T2-weighted MR image shows the "shading sign" (red arrow) with a hypointense right cyst lesion, (d) Sagittal T2-weighted MR image.
Fig. 9: Women of 30 years with bilateral endometriomas and endometriosis in the fallopian tubes. (a) Axial T1-weighted MR image shows a hyperintense in dilated fallopian tubes and ovaries. (b) Axial Fat-suppressed T1-weighted MR image shows more intensity in the same locations of a. (c) Axial T2-weighted MR image shows the "shading sign" (red arrows) with a hypointense ovarian cysts. The fallopian tubes are hyperintense and are unchanged in the T2-weighted MR image (black rhombus). (d) Sagittal T2-weighted MR image.
Fig. 10: Women of 36 years with endometriomas and deep infiltrating endometriosis. Axial T2-weighted image shows (a) hypointense nodular lesion of 14 mm x 9 mm with spiculated margins in the rectovaginal septum, in the right hemipelvis. Also, cysts bilateral and free peritoneal liquid. (b) Axial T2-weighted image shows other hypointense elongated lesion of 18 mm x 9 mm in the rectovaginal septum, in the right hemipelvis. (c) Axial T2-weighted image shows in the left hemipelvis a hypointense nodular lesion of 22 mm x 14 mm with spiculated margins in the rectovaginal septum. (d) Sagittal T2-weighted image of image a.
**Fig. 11:** Women of 51 years with chronic pelvic pain and history of deep infiltrating endometriosis. (a,b,c,d) Axial, coronal and sagittal T2-weighted MR images show hypointense, krimp, fibrotic lesion (red circle) in the right septum rectovaginal and to extend to mesorectal space with shrinkage of the mesorectal fascia, space pararectal and pelvic wall (red arrows).
Fig. 12: Women of 36 years and history of extensive endometriosis. (a) Axial T1-weighted MR image showing one hyperintense endometriotic foci approximately of 5 mm in the septum rectovaginal, this foci in (b) in Axial Fat-suppressed T1-weighted MR image is more intense. (c and d) Coronal and sagittal T2-weighted MR images with the same hyperintense endometriotic foci.
**Fig. 13:** Women of 34 years with intermitent dysuria and pelvic pain with suspicion of a rectal tumor by palpation of a mass on rectal examination. The hystopathology result was bladder endometriosis with rectal wall infiltration. (a,b) Axial and sagittal T2-weighted MR images show mild diffuse thickening of the bladder wall and hypointense mass with regular margins in the left posterolateral portion of the bladder wall that infiltrate the muscle detrusor projecting into the lumen (red arrow), (c,d) Sagittal and axial T2-weighted images show the perirectal infiltration and fibrosis (white arrow) mimicking the presence of a rectal tumor.
Fig. 14: Women with diagnosis of endometriosis in the fallopian tubes confirmed by hystopathological specimen. (a) Axial T1-weighted MR image shows hyperintense large and dilated fallopian tubes, and (b,c) Axial and coronal T2-weighted images show the shading sign in the fallopian tubes (red arrows), with hypointense signal in T2-weighted MR images.
Fig. 15: Axial and coronal T2-weighted MR images showing the "kissing ovaries": posterocentral retraction of the ovaries in the pelvic region, being located adjacent to each other (red arrows) due to peritoneal adhesions in the rectovaginal septum and retrocervical space.
**Fig. 16:** Axial T2-weighted MR image shows a 3cm mass in the rectosigmoid junction with form of "mushroom cap" (red square). Heterogeneous hypointense region of the hypertrophic muscularis propria (central region) covered with hyperintense region of mucosa and submucosa of the rectosigmoid junction. The hypertrophic muscularis propria make a fibrotic adhesion and convergence of the serosa due to invasion of endometriotic implant.
**Fig. 17:** Women with 39 years with frozen pelvis and intestinal symptoms. (a,b) Coronal and sagital T2-weighted MR images show important asimetric infiltration of the rectosigmoid junction with "mushroom cap sign" (black arrow), and fibrotic changes in the mesosigma. (c) Axial CT image shows the correlation with mushroom cap sign in CT.
**Fig. 18:** Axial and coronal T2-weighted images showing the mushroom cap sign in the rectosigmoid junction (red circle).
Fig. 19: Women of 46 years with diagnosis of bilateral endometriomas. In emergency department the patient begins with pain abdominal, diarrhea and nausea, which consisted of acute intestinal obstruction; the definitive diagnosis was ileal endometriosis and confirmed by histology of the resected lesions. (a,b,c) Axial and coronal sShT2-weighted enteroMR images showing significant generalized distension of yeyunal and ileal bowel loops with a change of caliber at the distal ileum where exist a hypointense short irregular thickening wall (red arrow) causing occlusive stenosis with acute intestinal obstruction.
**Fig. 20:** Women of 41 years with bilateral endometriomas and finding casual by images of endometriotic implant in right diaphragmatic dome (red circle) and confirmed by hystopathological specimen. (a) Axial in phase T1-weighted MR image shows an irregular and hyperintense lesion in right diaphragmatic dome that corresponds to endometriotic foci. (b) Axial fat-saturation T2-weighted MR image showing the same endometriotic implant more hyperintense. (c) Coronal T2-weighted images with hyperintense lesion. (d) Axial T1-weighted gadolinium MR image shows peripheral enhancement of the lesion in right diaphragmatic dome.
Fig. 21: Women of 41 years with bilateral endometriomas and finding casual by images of endometriotic implant in right suprarrenal gland (red circle). (a) Axial in phase T1-weighted MR image shows a nodular and hyperintense lesion in right suprarrenal gland that corresponding to endometriotic foci. (b) Axial fat-saturation T2-weighted MR image showing the same endometriotic implant more hyperintense. c) Coronal T2-weighted image with hyperintense lesion. (d) Axial T1-weighted gadolinium MR image shows high enhancement of the nodular lesion.
Fig. 22: Women of 32 years with history of deep infiltrating endometriosis. In a finding casual in thorax CT observed a nodular lesion, with regular margins in the left lower lobe, for two years with no changes in the size. The hystopathology confirmed endometriotic foci in the lung. (a,b) Axial and sagittal CT images show nodular lesion in the left lung base (white arrows).
Conclusion

Endometriosis is a disease frequently found in the pelvic region but also in extrapelvic organs. The gold standard diagnosis is laparoscopic surgery, although its use is currently very limited. CT an MR preoperative images provide locations and extension area of disease; showing the different radiological faces and improving identification, therapeutic procedures and treatment planning. MRI provide greater specificity, mainly for endometriomas and deep infiltrating endometriosis.

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