MRI atlas of ectopic endometriosis

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Abstract  Ectopic endometriosis is a common condition which is often underdiagnosed, where MRI can help make a diagnosis simply, non-invasively and without irradiation. However, imagery signs of it are enormously polymorphic with a wide range of possible locations. In this paper, we have tried to illustrate comprehensively all its MRI appearances depending on the different locations where it occurs.

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The prevalence of ectopic endometriosis is difficult to establish, often underestimated at between 5 and 10% [1,2], and more common in Caucasian women of childbearing age (20–40 years) with a frequency peak at 35 years of age [3,4].

It is defined as the presence of endometrial tissue outside the uterine cavity, the site of cyclic, proliferative activity, without menstrual elimination with bleeding then lysis and regeneration on contact by proliferation and/or fibrosis [5]. There are several theories concerning its pathophysiology including Meyer’s coelomic metaplasia theory, evoking the potential for differentiation of the mesothelium. Undifferentiated cells of the peritoneal layers could indeed be transformed into ectopic endometrial cells as a result of endometrial “induction” [6]. Sampson’s metastasis theory proposes the possible reflux of viable endometrial cells during menstruation, with “implantation” and haematogenous and lymphatic dissemination. The hormonal and immunological influence of the peritoneal fluid may also play a role by escaping from its regulating and protecting factors (cytokines, growth factors, hormones, etc.) [7].

Clinical examination is difficult, often with a delay in diagnosis and non-specific chronic symptoms, cyclic or continuous pelvic pain and secondary dysmenorrhoea being the most common, but deep dyspareunia, associated or not with painful defecation, also occurring, depending on the sites of the disease. Other events such as premenstrual metrorrhagia, haematuria associated with urinary symptoms or infertility may result in onset of the disease [8].

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MRI is very useful both where endometriosis is clinically suspected due to polymorphic clinical symptoms and also for short and long-term monitoring. It can help make a diagnosis in a simple, non-invasive and non-irradiating manner. However, MRI imaging signs are also extremely polymorphic with a wide possibility of sites [9].

For ease of understanding, we shall illustrate in this atlas, created from more than 2,200 pelvic MRIs, all MR imaging appearances of ectopic endometriosis according to its various intra-then subperitoneal locations. We shall also review the appearance of rare cases of endometrioid neoplasia.

Finally, for the sake of completeness, we will discuss the most common extrapelvic endometrioses (muscle, cutaneous and thoracic).

Locations of ectopic endometriosis

All the locations for pelvic ectopic endometriosis are summarised in Fig. 1, produced from Cullen’s model, with their correspondence with sagittal T2-weighted MRI images [10].

MRI signs and histopathology

MRI signs are highly polymorphic but can be characterised by the presence of lesions with haemorrhagic content of variable intensity, depending on the production of haemoglobin degradation products and their age, which may appear hyperintense with T1-weighting if recent or reasonably recent, hypointense with T1-weighting if old lesions, and be very variably intense in T2-weighting but generally hypointense [11]. Macroscopically, these lesions are haemorrhagic foci surrounded by an endometrial epithelium and stroma in the ovaries and haemorrhagic or fibrohaemorrhagic implants (Fig. 2).

More or less retractile fibrous lesions that are usually hypointense in T1 and T2-weighting are the second type of typical occurrence seen in MRI. In these situations, the macroscopic appearance is of fibrous lesions with adhesions secondary to inflammation of the peritoneum (Fig. 3).

Histologically, these fibrohaemorrhagic lesions are associated with a cylindrical glandular epithelium and endometrial stroma [5] with reactionary inflammatory proliferation, consisting of smooth muscle cells and fibroblasts, around the haemorrhagic lesions [1].

MRI atlas of ectopic endometriosis
Pelvic endometriosis

Intraperitoneal endometriosis

Ovarian and peri-ovarian endometriosis

Endometriomas (>1 cm) or micro-endometriomas (<1 cm) are characterised by intra-ovarian lesions of variable signal intensity, generally persistently hyperintense in T1-weighting on fat suppression sequences which are almost pathognomonic, and usually hypointense with T2-weighting producing “shading” (Fig. 4), sometimes with “mirroring” of the variously shaded levels (Fig. 5). The classic “coffee bean” appearance (Fig. 6) is also generally attributed to ovarian endometriomas.

Contrast agent injection reveals no annular enhancement producing the “ring sign”, thus differentiating them from haemorrhagic follicular cysts (Fig. 7).

There may be associated retractile peri-ovarian adhesions with a star-like appearance and variable intensity in the ovarian fossae which may in some cases bring the ovaries towards the midline area producing “kissing ovaries” (Fig. 8).

Peritoneal and retro-uterine pouch endometriosis

This is characterised by stellar adhesions (Fig. 9) and by simple thickening or an isolated nodule of the peritoneum (Fig. 10) of variable size and intensity, sometimes difficult to distinguish using MRI.

![Figure 1. Cullen 1919 modified in Maubon A, Rouanet JP, DiU Imagerie Gynécologique 2008–2009. 1: adenomyosis; 2: torus uterinus; 3: tubal lesion; 4: round ligament; 5 and 6: ovarian and peri-ovarian lesion; 7: uterosacral ligament; 8: intestinal lesion; 9: abdominal wall; 10: umbilicus; red arrow: vesicouterine pouch; blue arrow: rectovaginal pouch; green arrow: pouch of Douglas.](image-url)
Figure 2. Right ovarian endometrioma (white arrows) with recent haemorrhagic changes showing T1-weighted hyperintensity, hypointensity in T2-weighting on multi-follicular ovaries with related pathological anatomy (appearance of intra-ovarian haemorrhagic changes).

Figure 3. Peri-ovarian endometriosis with fibrous adhesions to the ovarian fossae, hypointense T1- and T2-weighted images and laparoscopic correlation with whitish fibrous implants.
Figure 4. T2-weighted hypointense appearance with "shading" of a specific right ovarian endometrioma.

Figure 5. Variously shaded levels with "mirror" appearance with T1-weighted haematic hyperintensity, T2-weighted hypointensity: left endometriomas of different ages.

Figure 6. Typical "coffee bean" appearance of a large right ovarian endometrioma with a thin wall without parietal contrast uptake.
Figure 7. Functional cyst in T1-weighted hypointensity and T2-weighted hyperintensity with "ring sign" parietal contrast uptake (black arrow), and endometrioma in T1-weighted hyperintensity and T2-weighted hypointensity without parietal contrast uptake (white arrow).

Figure 8. "Kissing ovaries": bilateral ovarian endometriosis with peritoneal adhesions bringing the ovaries closer to the midline.
Figure 9. Right peritoneal fibrous implants hypointense with T2-weighting, and corresponding laparoscopic image showing multiple peritoneal foci.

Endometriosis of the peritoneum of the vesicouterine pouch
There is no significant difference in this location in terms of signal regarding MRI signs. A lesion of the peritoneum of the vesicouterine pouch is characterised by disappearance of the inter-vesicouterine fat. Lesions to the dome of the bladder are often contiguous, with or without involvement of the bladder mucosa. A contiguous lesion of the anterior surface of the uterus is also possible without associated adenomyosis (Fig. 11).

Figure 10. Nodular peritoneal thickening of the pouch of Douglas.

Figure 11. Endometriosis of the vesicouterine pouch and contiguous extension to the anterior surface of the myometrium.
Tubal endometriosis
Unilateral or bilateral dilatation of the fallopian tubes very often with a heterogeneous signal, unlike true hydrosalpinx, may indicate an endometriotic origin (Fig. 12). In the majority of cases, these haematosalpinx are associated with other ectopic locations and are rarely isolated.

Intraperitoneal bowel endometriosis
Attraction of the anterior surface of the intestinal wall at an obtuse angle, associated with a poorly defined mass or nodule caused by fibromuscular hyperplasia of variable size in contact with it is highly suggestive of an intestinal lesion. The mass is hypointense in T2-weighting (Fig. 13) due to hyperplasia of the muscula propria and shows submucosal and mucosal hyperintensity, exhibiting what is termed the ”mushroom cap” sign (Fig. 14); it may involve the small intestine (Fig. 15).

Subperitoneal pelvic endometriosis
Endometriosis of the torus uterinus, the uterosacral ligaments and the retrovaginal pouch
Anatomically, a lesion of the torus uterinus is a lesion of the subperitoneal space behind the cervix of the uterus (Fig. 16), above the rectovaginal pouch (Fig. 17) between the posterior surface of the vagina and the rectum. The uterosacral ligaments arise from either side of the torus uterinus on the posterior surface of the uterus and their involvement (Figs. 18 and 19) may be isolated or contiguous.

MRI signs in terms of morphology and signal have no particular locoregional features.

Figure 12. Bilateral large heterogeneous haematosalpinx with the appearance of tubules, increasing to the right.
**Figure 14.** Haemorrhagic endometriosis of the anterior surface of the sigmoid colon with anterior attraction.

**Figure 15.** Small intestine lesion lateralised to the left with associated intraperitoneal effusion.
intraperitoneal (Fig. 21). If the mucosa is involved, the ring of digestive mucus is interrupted (T1-weighted hyperintensity is interrupted following gadolinium injection) (Fig. 22).

**Endometriosis of the cervix, vagina and round ligaments**
This is characterised by a nodular lesion with a variable signal at the cervix (Fig. 23), in the vagina (usually in the posterior fornix) (Figs. 24 and 25) or involving the round ligaments (Fig. 26).

**Endometrioid neoplasia**
This degeneration affects less than 1% of cases of endometriosis. Its diagnosis remains histological with no specific MRI signs for the neoplastic component (Fig. 27).

**Extrapelvic endometriosis**

**Muscle and subcutaneous endometriosis**
This is the most frequent extrapelvic condition concerning endometriosis and is either primary or occurs via a laparoscopic trocar if it is an anterior parietal muscle lesion (Fig. 28). The latter causes the same characteristic abnormal signals as intrapelvic endometriosis and can also affect areas of the skin (the anterior skin wall (Fig. 29), the gluteal fold (Fig. 30), the canal of Nuck (Fig. 31), etc.).

**Thoracic endometriosis**
Thoracic endometriosis can be responsible for pneumothorax or haemopneumothorax in asymptomatic patients, or be associated with advanced pelvic lesions (Fig. 32).
Figure 17. Large rectovaginal endometriotic nodule hyperintense in T1-weighting and hypointense in T2-weighting, pushing the vagina forward.

Figure 18. Haemorrhagic endometriosis of the right uterosacral ligament.
Figure 19. Fibrous endometriosis with thickened appearance of the left uterosacral ligament.

Figure 20. Left ureteral dilatation proximal to a fibrous subperitoneal and ovarian lesion sheathing the lower ureter.
Figure 21. Subperitoneal intestinal fibrous macronodule at the rectosigmoid junction not affecting the intestinal mucosa.

Figure 22. Subperitoneal rectosigmoid lesion involving the mucosa by rupturing the submucosal ring – T1-weighted sequence after gadolinium injection and fat suppression.
Figure 23. Endometriosis of the posterior surface of the cervix hyperintense in T1 and T2-weighting.
Figure 24. Endometriosis of the right lateral fornix with an overall hypointense signal indicating a fibrous nature.

Figure 25. Multiple haemorrhagic endometriotic nodular lesions of the posterior wall and the posterior fornix of the vagina.
Figure 26. Endometriosis of the left round ligament at its origin near the uterine horn.

Figure 27. Endometrioid neoplasia on pre-uterine endometriosis and endometriosis of the retro-uterine pouch (on a postpartum uterus) represented by a large heterogeneous mass with no specific signal abnormality.
Figure 28. Parietal endometrioid location in the left rectus abdominis muscle with considerable uptake of contrast after gadolinium injection.

Figure 29. Anterior subcutaneous location on laparoscopy scars.
Figure 30. Subcutaneous endometriosis of the gluteal fold, lateralised to the right in this patient who initially consulted because of intermittent rectal bleeding.

Figure 31. Endometriosis of the canal of Nuck (remnant of the peritoneo-vaginal canal in women) on the right.

Figure 32. Right diaphragmatic and perihepatic locations with no haemopneumothorax, discovered incidentally in a patient with known intra- and subperitoneal associated endometriosis.
Conclusion
The lesions of endometriosis are widely polymorphic in terms of signal, with a great many possible locations which are more often than not associated, hence the importance of precise knowledge of the various typical appearances.

Disclosure of interest
The authors declare that they have no conflicts of interest concerning this article.

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