Imaging of intestinal involvement in endometriosis

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Abstract
Deep gastrointestinal involvement in endometriosis is characterised by fibrous, retractile thickening of the intestinal wall. The most common location is the upper rectum, in contiguity with a lesion of the torus uterinus. As part of a preoperative assessment, it is essential to establish an accurate and exhaustive map of intestinal lesions so that the surgeon can plan his actions. Transvaginal sonography and MRI correctly analyse pelvic and rectal involvement. Given the frequency of multiple intestinal sites, particularly sigmoid and associated ileo-caecal lesions, water enema CT should be performed. The role of rectal endoscopic sonography is debated.

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Endometriosis is a common chronic gynaecological disease affecting 10 to 15\% of women of reproductive age [1]. It is defined by the presence of functional ectopic endometrial tissue outside the uterus. Depending on the site of the endometrial implants, three main
Some essential points concerning deep pelvic endometriosis

There are two non-consensual definitions of deep pelvic endometriosis: sub-peritoneal implants penetrating for more than 5 mm under the peritoneum or infiltration of the uterosacral ligaments and/or the muscles of adjacent pelvic organs.

Deep pelvic endometriosis is responsible for chronic pelvic pain (dysmenorrhea, deep dyspareunia), with or without menstrual aggravation, but also dyschezia, rectorrhagia and dysuria. It is also responsible for infertility with a frequency estimated at 20 to 40% in cases of infertility. Rarely, endometriosis is asymptomatic.

Its pathogenesis has not been elucidated. Several hypotheses have been discussed including reflux of endometrial fragments through the fallopian tubes during menstruation, metaplasia of tissues derived from the coelomic epithelium into endometrial tissue, vascular and/or lymphatic emboli, and involvement of epigenetic and environmental factors.

The diagnosis is often made too late, after an average 7 years of pain developing or after several years of medically assisted procreation treatment. Endometriosis can be suspected clinically but imaging is the procedure that confirms it and maps the lesions. Laparoscopy should not be performed for diagnostic purposes because it is not without risk and can ignore some deep lesions or those masked by adhesions.

Sites of deep endometriosis

Lesions of the uterosacral ligaments are the most common (Fig. 1). They are associated with involvement of the torus uterinus, which is a small transverse thickening on the posterior surface of the cervix, between the insertions of the two uterosacral ligaments.

Intestinal and urinary tract locations are the most severe forms of deep endometriosis (Fig. 2). The multiple intestinal sites represent up to 55% of the cases in the recent study by Piketty et al. [2,3]. The histologically proven rate of association, in this study, with proximal ‘right’ intestinal (caecal or ileal) lesions was 28% in patients with rectal and/or sigmoid locations.

The usefulness of pre-treatment imaging

Different therapeutic strategies

Hormonal treatment of endometriosis can be effective on the painful symptoms but does not improve fertility. It is the first-line drug to patients with pain and no desire to become pregnant. Surgical treatment is offered to patients whose pain is not sufficiently improved by medical treatment and also to patients who wish to become pregnant after two IVF failures. Surgical treatment does indeed improve pain, quality of life and fertility, provided that the lesions are completely removed [4].

![Diagram showing the frequency of different intestinal deep endometriosis lesions according to Piketty’s et al. study [2].](image)

![Table showing the frequency of deep pelvic endometriosis according to Chapron’s surgical serie [3].](table)
There are two possible surgical techniques: a radical technique with segmental resection and anastomosis or a shaving technique. The first reduces the risk of recurrence more but has a higher incidence of severe complications, particularly of rectovaginal fistula.

What does the surgeon expect from a preoperative radiological examination?

As with cancer, the success of laparoscopic treatment depends on complete excision of the lesions. A radiological examination to map all the lesions exhaustively is therefore necessary in symptomatic patients to determine the surgical strategy and inform the patient of the risks.

The prime objective of mapping is to describe the precise location of the intestinal lesions (with measurement of the distance of rectal lesions from the anal margin, because a low rectal anastomosis may require protection by an ostomy), the depth of the lesions (with or without muscular involvement) and the number of lesions. Indeed, a proximal ‘right’ intestinal lesion combined with rectal involvement will result in a double segmental resection by laparotomy rather than laparoscopy.

The secondary objective of mapping is to describe other locations of deep pelvic endometriosis, which will also have to be treated and which could form morbid associations. Where there is an associated ureteral lesion, it is important to warn the patient of the risk of transient postoperative dysuria and ureteral fistula, especially if a ureterovesical anastomosis with a psico bladder is planned. In the event of an associated lesion of the vagina or the pouch of Douglas, the surgeon may decide to perform a temporary ileostomy to reduce the risk of a rectovaginal fistula. Indeed, the ostomy promotes healing of the two sutures (vaginal and rectal) one opposite the other.

Imaging methods and protocols

Transvaginal ultrasonography

Transvaginal ultrasound can be performed at any time in the cycle and is guided by any pain experienced as the probe passes. Combined with systematic examination of the renal system, it helps analyse the urinary excretory cavities, which may be dilated where there is infiltration or compression of the lower urinary tract.

Prior rectal enema permits better examination of the rectum: this is systematic for some teams, optional for others.

The quality of the examination may be adversely affected by pain, by a strongly retroflexed or retroverted uterus or uterine myomas. Its efficacy depends on the experience of the operator, the learning curve being long.

Magnetic resonance imaging (MRI)

MRI can be performed at any time in the cycle. Simple techniques, such as a moderately full bladder, an abdominal retaining strap and administration of antispasmodics just before the examination, help reduce intestinal peristalsis, which can mimic thickening of the colon or mask small lesions.

The three essential sequences are an axial T1-weighted sequence with fat saturation, an axial oblique T2-weighted sequence with 3 mm slices (in the plane of the uterosacral ligaments, i.e. perpendicular to the cervix) and a sagittal T2-weighted sequence. Another sequence, useful but considered optional by some teams, is a coronal T2-weighted sequence to examine the sigmoid colon better [5]. 3D T2-weighted sequences could possibly replace the T2-weighted sequences of this protocol but have poorer spatial resolution.

Prior rectal enema, administration of an aqueous intravaginal gel (which can mask hyperintense spots in the vaginal wall in T2-weighted images), rectal opacification with an aqueous gel (which is uncomfortable, increases peristalsis of the colon and can make intestinal parietal retraction disappear by pressing the digestive wall against the uterus) or gadolinium injection, are optional procedures [6].

Large endometriomas, subserosal leiomyomas (especially retrocervical) and considerable retroversion of the uterus can reduce the quality and sensitivity of the examination.

Enema computed tomography

Prior colonic enema is optional. On the other hand, lower digestive tract opacification with water or water-soluble contrast agent is required. Ileal reflux is usually sufficient to visualise most sites in the small intestine. Single helix is essential, performed 70 seconds after injection of the iodinated contrast agent. Secondarily coupled with a late phase, the CT scan can detect certain ureteral locations. Multiplanar reconstruction can be performed and distances between lesions and anatomical landmarks (the anal margin, the ileo-cecal valve) measured. It is less sensitive than MRI to peristalsis and residues of matter. Irradiation limits its use in women who wish to become pregnant.

Rectal endoscopic sonography

This examination is performed after administration of laxatives the day before and an enema an hour before the examination. It is more reliable under general anaesthesia. The high frequency probe is first positioned in the sigmoid colon before being slowly withdrawn towards the rectum. Instillation of liquid into the lumen of the intestine allows the wall of the digestive tract and adjacent structures to be examined.

Preoperative imaging: the usefulness of the various examinations

With its excellent spatial resolution, transvaginal ultrasound is the best diagnostic examination for ovarian, anterior sub-peritoneal (uretovesical pouch, bladder wall and insertion of the round ligaments) and posterior sub-peritoneal (uterosacral ligaments, torus uterinus, vaginal fornices, pouch of Douglas, rectum and rectosigmoid junction) lesions [2,7,8]. On the other hand, it can miss lesions of the rectovaginal septum and sigmoid colon because of their distance
from the probe or the presence of faecal matter. Using a transparietal examination with a surface probe in these generally slim patients can however increase the detection of sigmoid sites. Even with a great deal of ultrasound experience, it is difficult to measure the distance between the lower edge of the lesion and the anal margin.

The anterior and posterior compartments can also be examined with pelvic MRI, which is easier to learn than ultrasound. It is of equivalent value to transvaginal ultrasonography for diagnosing rectal involvement [7] but its sensitivity for examining the uterosacral ligaments and vagina is better. However, distinguishing between serous and deep lesions can be difficult in MRI, which may also miss sigmoid, caecal/appendicular or small intestine lesions.

Enema CT is a preoperative examination performed to detect multiple intestinal sites. Rectal sites are identified as well by ultrasound as with MRI or CT. On the other hand, sigmoid, caecal/appendicular or terminal small intestine lesions are more easily diagnosed using CT [10], which can localise them relative to the anal margin or the ileo-caecal valve. Abdominal peritoneal locations are easier to identify with a CT scan. Diaphragmatic and pleural locations, excluding exceptional transdiaphragmatic liver hernia, cannot be detected by imaging.

Rectal endoscopic sonography (Rectal ES) is the most reliable means of measuring the exact distance between the lower edge of the lesion and the anal margin. It precisely detects the degree of infiltration of the rectosigmoid wall. However, it adds little value over transvaginal ultrasound performed by an experienced operator [2]. This is why some teams no longer recommend it in systematic preoperative examinations of rectosigmoid lesions but do recommend it where there is doubt or radio-clinical disagreement [7].

**Examination of rectosigmoid involvement**

**What imagery detects**

Ectopic endometrial tissue implants are subject to hormonal variation and therefore show chronic bleeding. Their morphology varies depending on the pelvic site affected.

Since the size of superficial peritoneal involvement is in millimetres, it remains the prerogative of laparoscopy; it is difficult to detect in imaging, except for ovarian pericortical punctiform hyperechoic spots. Ovarian involvement results in the formation of haemorrhagic cysts typically with marked high intensity in T1-weighted images with fat suppression and with homogeneous or heterogeneous low intensity in T2-weighted images.

However, involvement of anatomical structures composed of smooth muscle (vagina, digestive tract or bladder) leads to the formation of retractile fibrous nodules related to fibromuscular hyperplasia. Endometriotic foci themselves are only detected if they are cystic or haemorrhagic. The size of the nodule varies: some lesions affecting several adjacent anatomical structures can coalesce.

**Transvaginal ultrasonography**

Rectosigmoid involvement is generally a contiguous extension of retrocervical endometriosis affecting the insertion of the uterosacral ligaments. Investigation of intestinal involvement comprises, first of all, examination of the uterosacral ligaments. To do this, the simplest thing is to sweep the uterine cervix from one side to the other in sagittal section. A normal uterosacral ligament is not seen with ultrasound unless it is silhouetted due to an intraperitoneal effusion. A uterosacral ligament is pathological when it is visible in the absence of effusion and if its proximal part is the site of irregular nodular hypoechoic thickening (Fig. 3).

Involvement is usually bilateral and asymmetric but it can be unilateral, more often on the left.

Rectosigmoid involvement may be of the superficial serosa alone and appear as an adhesion between the serosa and the torus uterinus. When pressure is exerted on the probe, the rectum moves less than normal.

Deep rectosigmoid involvement appears as nodular thickening in the muscularis (Figs. 4 and 5). This nodule is poorly vascularised and hypoechoic, has irregular contours and is joined at an obtuse angle to the rectal wall. The most common site of involvement is the middle or upper rectum (between 66 and 96% of cases of intestinal endometriosis according to studies [2,3]), behind the torus uterinus. In this case, the nodule may be detected during a rectolaparoscopic examination for diagnostic purposes.

*Figure 3.* Transvaginal ultrasonography showing involvement of the uterosacral ligaments in two patients. **a:** regular linear thickening of a uterosacral ligament (between callipers). **b:** irregular thickening of a uterosacral ligament (between callipers) in sagittal section with contiguous rectal involvement (arrow).
site, the nodule is attracted to the torus uterinus with disappearance of the normal hyperechoic fatty layer between the uterine cervix and the rectum. Once the lesion has been identified, several details should appear in the report: the size of the lesion, the percentage of the circumference (estimated on an axial section), the degree of infiltration of the wall, the distance between its lower edge and the anal margin. Ultrasound assessment of the latter is only an approximation, considering that the pouch of Douglas is 7 to 9 cm from the anal margin.

The ultrasound report will also concentrate on providing a map of the other pelvic lesions. Complete obliteration of the pouch of Douglas must be looked for in particular, when retrocervical, adnexal and rectosigmoid lesions coalesce.

Magnetic resonance imaging (MRI)

Unlike in ultrasound, a normal uterosacral ligament is seen in MRI. Its axis is perpendicular to the axis of the cervix. Ligament involvement is seen as asymmetric nodular thickening which is iso- or hypointense relative to the myometrium in T2-weighted images. Involvement of both uterosacral ligaments is associated with involvement of the torus uterinus visible as a retrocervical arcuate thickening (Fig. 6a).

Rectosigmoid involvement may be a superficial serosal lesion. This is visible in the form of an adhesion with disappearance of the fatty border on the serosa.

Deep rectosigmoid involvement appears as nodular thickening in the muscularis of the rectum or sigmoid colon, joined at an obtuse angle to the wall [9] (Fig. 6b and c). The parietal nodule appears retractile: it is triangular with the point towards the torus uterinus and may have a stellar outline. It has a signal similar to that of the pelvic muscles in T1 and T2-weighted images. Mucosal involvement is rare; it appears as a burgeoning transmural mass.

Sometimes, in T1-weighted images with fat saturation, hyperintense spots can be distinguished within the fibrous nodule, corresponding to haemorrhagic implants (Fig. 7a). A few punctiform cysts, which are hyperintense in T2-weighted images may also be seen (Fig. 7b): they are endometrial glandular crypts distended by adhesion effects.

As with ultrasound, the examination will concentrate on describing the degree of parietal extension, the distance between the lower border of the endometriotic mass and the anal margin and whether or not the pouch of Douglas has been obliterated.

Figure 4. Sagittal transvaginal ultrasonography showing, in two patients, typical retrocervical lesions. a, b: hypovascular nodular thickening (arrows) of the muscularis layer of the upper rectum, which can be regular (a) or irregular with adhesion to the torus uterinus (b). Normal appearance of the muscularis layer adjacent to the nodule: thin and hypoechoic (star).
Enema computed tomography

Intestinal involvement results in poorly vascularised nodules of fibrosis of tissue density, on the wall of the intestinal tube (Fig. 8). They appear retractile on adjacent structures to which they can become attached (Figs. 9 and 10) [10].

Rectal endoscopic sonography

The signs of rectosigmoid endometriotic nodules are the same here as in transvaginal ultrasonography (Figs. 11 and 12). The degree of parietal involvement is easier to analyse because the differentiation between parietal layers is better: the hypoechoic muscularis layer can be distinguished better from the hyperechoic submucosa. Apart from the degree of parietal infiltration, the examination report should give the size of the lesion, its location relative to the anal margin and infiltration into adjacent organs.

Figure 5. Transvaginal (a, b and c) and suprapubic (d) ultrasonography in the same patient. a: nodular thickening of the right uterosacral ligament (between callipers). b: nodular thickening of the wall of the upper rectum (between callipers), adhering to the torus uterinus. c: nodular thickening of the wall of the terminal ileum (between callipers). d: nodular thickening of the wall of the sigmoid colon (between callipers), seen with a superficial probe.
Figure 6. Axial (a, b) and sagittal (c) T2-weighted MRI images. a: typical retrocervical involvement: hypointense thickening of both uterosacral ligaments (arrow) and the torus uterinus, giving an arcuate appearance. b, c: typical involvement of the upper rectum in another patient: triangular right anterior lateral nodule of the rectal wall (arrows). The right uterosacral ligament adhesion has a stellate appearance.

Figure 7. T1-weighted after fat saturation axial MRI slices (a) and T2 weighted (b). a: haemorrhagic spot on the left uterosacral ligament (arrow) appearing hyperintense. b: retrocervical and upper rectal lesions: thickening of the uterosacral ligament adhering to a left anterior lateral rectal nodule (arrow). Both sites are dotted with hyperintensities (cystic spots).
Figure 8. Water enema CT showing typical retrocervical involvement: nodule (arrow) of the anterior wall of the upper rectum adhering to the torus uterinus. a: axial slice. b: sagittal slice.

Figure 9. Water enema CT showing parietal thickening of the sigmoid colon (arrow) contiguous with a left ovarian lesion (star). a: axial slice. b: sagittal oblique reconstruction.
Figure 10. Water enema CT showing four sites of intestinal endometriosis in the same patient. a: nodular thickening of the torus uterinus adhering to the anterior surface of the upper rectum. b, c: Thickening of the wall of the sigmoid colon (arrow) in axial (b) and oblique sagittal (c) slices adhering to the torus uterinus and the left ovary (site of several endometrioma detected by ultrasound). d, e: rounded nodule in the wall of the final loop of the ileum (arrow) in axial (d) and coronal (e) slices. f: parietal thickening of an ileal loop (arrow) in contact with the right ovary which is also involved.
Figure 11. Rectal ES - axial section. Nodular hypoechoic thickening of the muscularis (arrow). Submucosa (thin, hyperechoic appearance [arrowhead]) spared. Normal appearance (hypoechoic and fine) of the muscularis (star).

Figure 12. Muscularis involvement at the rectosigmoid junction, with correlation in transvaginal ultrasound (a), MRI (b), Enema CT (c), rectal ES (d). a: sagittal slice showing hypoechoic nodular thickening of the muscularis (arrow). b: T2-weighted axial slice showing an arcuate hypointense thickening of the uterosacral ligaments. On the right, this thickening is adhering to an intestinal parietal nodule. c: oblique sagittal reconstruction showing a single intestinal location. d: nodule in the muscularis layer, sparing the submucosa, located 20 cm from the anal margin.
Conclusion

Endometriosis is often diagnosed late even though it is essential to diagnose it as early as possible so that patients can receive appropriate treatment and, if necessary, surgery, to reduce pain and improve fertility.

Surgical excision must be complete to be effective; the preoperative examination is therefore an essential prerequisite for successful treatment. It must establish a precise map of all the endometriotic lesions, especially the intestinal lesions, with their size, exact topography and the degree of parietal infiltration. With this examination report the surgeon can plan what he will do and inform the patient of any particular risks.

Disclosure of interest

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

References


