MRI in endometriosis

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Dr Piers Osborne
Specialist registrar in radiology

Dr Nishat Bharwani
Consultant radiologist

Imperial College Healthcare NHS Trust, London

Background

Endometriosis is a common gynaecological condition affecting women of reproductive age, with some patients remaining asymptomatic while others suffer significant symptoms. The estimated prevalence varies between 2% and 10% within the general female population, although it may be as high as 50% in infertile women. It is defined as the presence of functional endometrial glands and stroma outside of the uterine cavity.

This ectopic tissue responds to hormonal changes resulting in cyclical haemorrhage and pain, giving the disease its clinical features. The ovary is the commonest site of endometriotic involvement, with endometriomas seen in 20-40% of cases. Involvement of the pelvic peritoneum by deposits invading greater than 5mm in depth is known as deep pelvic endometriosis (DPE).

Aetiology

While the aetiology of endometriosis is not fully understood, there are several theories including retrograde menstruation, metaplastic and induction theories which are discussed in detail elsewhere.

Staging

The American Society of Reproductive Medicine characterises endometriosis into four stages: I – minimal, II – mild, III – moderate and IV – severe. The stage depends on the size, location and depth of endometriotic implants; the presence and size of endometriomas as well as the presence and severity of adhesions. Symptomatology appears more closely related to the location of lesions rather than the extent of disease.

Diagnosis

The definitive diagnosis relies on histological confirmation of endometrial glands and stroma outside of the endometrial cavity and the current gold standard for evaluation is laparoscopy and biopsy. However, imaging is increasingly employed initially as a non-invasive assessment tool or to plan the surgical approach.

The first line imaging modality is transvaginal ultrasound (TVUS) which can often fully characterise ovarian endometriosis. However, DPE is better assessed with MRI which allows more complete evaluation of the pelvis with its high resolution, multiplanar capabilities and larger field of view.

The use of MRI offers the following advantages:

1. Excellent at demonstrating the haemorrhagic content (new and old) of endometriomas.
2. Used in identifying the presence of deeply-infiltrating endometriotic implants.
3. Particularly useful in pre-operative assessment of disease distribution and the presence of adhesions, especially within the posterior compartment and pouch of Douglas which helps guide subsequent laparoscopic surgery.
4. Vital as a problem-solving tool when assessing an ultrasound-indeterminate adnexal mass, helping differentiate ovarian cystic and solid lesions from endometriomas and also in the detection of malignant transformation within an endometrioma.

MRI protocol

Every institution will employ slightly different protocols for MRI in endometriosis. Recent guidelines from the European Society of Urogenital Radiology (ESUR) makes the suggestions listed in tables 1 and 2. Of particular note, if there is clinical and/or radiological suspicion of malignant transformation within an endometrioma, specific adnexal mass characterisation protocols which include dynamic contrast-enhanced sequences and subtraction imaging, should be employed.

MRI findings

There are three types of endometriosis described:

- Superficial peritoneal endometriosis
- Ovarian endometriosis
- Deep pelvic endometriosis.

Superficial peritoneal endometriosis

These are small and superficial endometriotic plaques and lesions which penetrate less than 5mm of the peritoneum. They are not detectable at ultrasound and are usually difficult to identify on MR imaging. Although fat-saturated T1-weighted sequences can help pick up small lesions (as they will appear bright), their small size and the fact that MR images are usually taken at 5mm intervals means that small lesions are often missed.

Characteristically, the deposits can be located on the ovaries, uterosacral ligaments and peritoneum. Not only do these plaques cause less fibrosis and structural change within the pelvis, but they tend to be less symptomatic.

Ovarian endometriosis

The ovaries are the commonest site involved with endometriosis. Blood-filled cysts are seen associated with the ovaries, resulting in ovarian enlargement. They can be unilateral or bilateral and are usually multiple. Adhesions can form between endometriomas and adjacent structures and the typical appearance seen in the presence of DPE is referred to as ‘kissing ovaries’, where the ovaries are drawn to the midline and tethered to the posterior uterine surface by posterior compartment disease.

Ultrasound is the first line imaging modality employed, but when seen on MRI they have typical characteristics (figure 1A-D). On T1W images, these usually appear bright as they contain blood products and do not show any signal loss on fat-suppression sequences. On T2W sequences, they show characteristic shading and layering caused by haemorrhage of varying age. Endometriomas classically have thickened walls which are of low T1/T2W signal due to haemosiderin deposition following repeated bleeds.

Deep pelvic endometriosis

DPE is defined as subperitoneal invasion by endometrial tissue and stroma that exceeds 5mm in depth. It is frequently associated with dysmenorrhea, dyspareunia, pelvic pain, urinary tract symptoms and infertility. Unusual findings such as pneumothorax and epistaxis may be seen when endometriotic implants occur in atypical locations outside

• Deep pelvic endometriosis.
the pelvis. The patient’s symptoms are usually directly related to the site and depth of invasion, with most of these lesions not palpable on digital pelvic examination.

Deeply-infiltrating plaques are typically seen as solid nodules with spiculated margins. They are of low T2W signal intensity, although they may contain small, punctate foci of high T2W signal. On T1W imaging, they are of intermediate to low signal, but can contain foci of high T1W signal.

When determining the extent and location of DPE, the pelvis is usually separated into three compartments:

- **Posterior compartment:** Rectum and surrounding connective tissue. The posterior compartment is the most common site of DPE with almost 70% of patients showing disease involving the torus uterinus (the position on the posterior aspect of the cervix where the uterosacral ligaments attach) and/or uterosacral ligaments.14

One of the advantages of MRI in DPE is its ability to assess for disease in this area which may not be identified clinically or using TVUS. Surgically this is important as it often directly alters the approach, as to assess the posterior compartment laparoscopically the peritoneum needs to be excised.

Rectosigmoid endometriosis has been demonstrated to occur in between 10% and 37% of patients and is almost always associated with disease at the torus uterinus.15,16 Vaginal and/or rectal contrast can help assess disease burden within the pouch of Douglas on MRI. Patients often describe symptoms of cyclical pain, bloating and bowel cramps relieved by passing air or faeces. Bowel serosal deposits will often appear as ill-defined areas of hypotense T2W thickening (figure 2A-B).

The gynaecological surgeon will want as much detail as possible about the extent and depth of bowel involvement to triage patients, as surgical options include shaving plaques off the bowel, discol resection or complete segmental resection.

- **Middle compartment:** Uterus, ovaries, fallopian tubes, vagina, broad ligaments and peritoneal folds. Endometriosis involving the ovaries, as described above, is typically not characterised as DPE. When DPE involves the uterus, implants can be seen on the serosal surface with plaques even extending to infiltrate the outer myometrium (figure 3). This is the reverse of adenomyosis, where endometrial tissue is demonstrated within the myometrium extending out from the junctional zone.

Vaginal endometriosis often involves the posterior vaginal fornix, resulting in obliteration of the normal low T2 signal intensity and the presence of either vaginal-wall thickening or a mass located posterior to the cervix. Identification is important as it may alter the type of surgery performed, particularly as there is an increased risk of recto-vaginal fistula formation. However, this is a site that is easily assessed with clinical examination and so imaging plays a small role here.

The broad and round ligaments can also be involved and will appear on MRI as thickened and nodular. Contrast enhancement can occur, especially if there is an associated inflammatory reaction.17 Fallopian tube involvement is usually subserosal, with a strong association with infertility and development of hydro/dermo-matosalpinges.

- **Anterior compartment:** Bladder and urethra. Endometriotic implants can imbed deep into the vesicovaginal septum, vesicoureteric pouch, the ureters (potentially resulting in ureteric obstruction) as well the detrusor muscle, which forms the bladder wall.

Most cases of endometriosis which involve the urinary tract are asymptomatic, although patients can experience symptoms of dysuria, urgency and macroscopic haematuria. Isolated bladder involvement is rare and there is usually also disease present in the posterior compartment. As demonstrated in figure 4A-B, the most common site of disease involves the bladder dome in the vesicoureteric pouch and endometriotic plaques can extend through the full thickness of the bladder wall, presenting as a bladder mass. Ureteral involvement is also rare and is often insidious, resulting in gradual loss of renal function. This tends to be secondary to extrinsic rather than intrinsic disease.19

**Malignant transformation**

While endometriosis is not a pre-malignant condition, it does have malignant potential, with transformation seen in less than 1% of patients.19 In these cases, approximately 75% represent malignant degeneration within ovarian endometriomas with the remaining 25% occurring at extra-ovarian sites. The commonest underlying histologies are clear cell and endometrioid carcinoma. MRI features that suggest malignant degeneration within an endometrioma include enhancing mural nodules, mural nodules >3cm, loss of T2W shading and interval enlargement.20

**Summary**

Endometriosis is a common gynaecological condition that can range from severely symptomatic to asymptomatic, with potential detrimental effect on fertility. The severity of the clinical presentation appears more closely related to the site(s) of disease involvement rather than the extent of disease present. Many patients will be diagnosed and managed using a combination of clinical history, examination and TVUS. MRI is used to detect DPE and guide potential surgical management, with a further role in assessing indeterminate adnexal masses.

Imaging requests should come from clinicians experienced in managing endometriosis, with standard MRI protocols adapted to help answer specific clinical questions.

**References**

Figure 1A-D
Typical appearances of ovarian endometriomas on T2W (A-B), T1W (C) and T1W with fat-saturation (D) MRI sequences.

Figure 2A-B
Endometriotic deposit with full thickness bowel involvement (pink arrows).

Figure 3
Large posterior myometrial endometriotic plaque extending from the torus uterinus towards the uterine fundus, causing uterine retroflexion.

Figure 4A-B
Coronal and sagittal T2W imaging demonstrating disease involving the anterior-superior bladder (orange arrows), as well as the torus uterinus (green arrow). The sagittal image also shows an ovarian endometrioma (blue arrow).
### Table 1

**Recommendations for patient preparation and positioning.**

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>At the discretion of the imaging centre</th>
<th>No specific recommendation (insufficient evidence in the medical literature)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fasting between 3-6 hours prior to the examination to reduce bowel peristalsis</td>
<td>Rectal and/or vaginal opacification to help diagnose DPE</td>
<td>Timing of MRI in relation to menstrual cycle</td>
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<tr>
<td>Bowel preparation, using either a low-residue diet or enema</td>
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<td>A moderately full urinary bladder</td>
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<tr>
<td>Anti-peristaltic agents to limit artefact from bowel movement</td>
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<td>Supine positioning, with prone positioning as an option for claustrophobic patients</td>
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<td>Abdominal strapping to reduce breathing artefact</td>
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</tbody>
</table>

### Table 2

**Recommendations for MRI protocol.**

<table>
<thead>
<tr>
<th>Recommended in all MRI examinations for endometriosis</th>
<th>At the discretion of the imaging centre</th>
<th>No specific recommendation (insufficient evidence in the medical literature)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pelvic phased-array coil</td>
<td>Magnet strength, either 1.5T or 3.0T</td>
<td></td>
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<tr>
<td>Three 2D-T2W MRI sequences (sagittal, axial, oblique) to help evaluate DPE</td>
<td>Addition of a 3D-T2W MRI sequence</td>
<td>IV contrast enhanced sequences for evaluation of DPE *</td>
</tr>
<tr>
<td>T1W MRI sequences with and without fat suppression</td>
<td></td>
<td>Diffusion-weighted imaging (DWI) and susceptibility-weighted imaging (SWI)</td>
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</table>

*If there is clinical or radiological suspicion of malignant transformation on the background of endometriosis, dynamic contrast enhanced imaging should be performed.

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**Table 1**

Recommendations for patient preparation and positioning. DPE – deep pelvic endometriosis.

**Table 2**

Recommendations for MRI protocol. IV – intravenous; T1W – T1-weighted; T2W – T2-weighted.