Role of MRI in detection of deep infiltrating endometriosis

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Learning objectives

To illustrate the typical MR imaging findings of deep infiltrating endometriosis, describe the different locations of solid endometriosis and review MR imaging protocol in affected patients.
Background

Endometriosis is a severe gynecologic disorder that affects women of reproductive age [1,2,3]. It is defined as the presence of functional endometrial glands and stroma outside the uterus [6,8]. There are three forms of pelvic endometriosis - superficial peritoneal lesions, ovarian endometrioma and deep infiltrating endometriosis. The superficial peritoneal lesions are noninvasive implants that can be easily diagnosed at laparoscopy [12,13]. Ovarian endometrioma is a widely known disorder that can be easily detected with US, MRI and laparoscopy [5,14,15,16]. The deep infiltrating endometriosis is defined as subperitoneal endometrial lesions that exceeds at least 5 mm beneath the peritoneal surface [3,11]. It can affect retrocervical region, rectosigmoid colon, urinary bladder and ureters, uterosacral, broad and round ligaments of the uterus, vagina [9,10].

The deep pelvical endometriosis is frequently associated with dysmenorrhea, dyspareunia, dyschezia, urinary disorders, pelvic pain and infertility [4]. This condition requires complete surgical excision of all the endometrial lesions for successful outcomes [7]. Less extensive surgery can be associated with clinical recurrences requiring additional treatment. Because of that preoperative correct evaluation of the location and the extent of endometrial lesion are extremely important. MR imaging is a noninvasive method that allow to identify all pelvic structures (with sub- and intraperitoneal location) and seems to be useful in diagnosis of all endometriosis locations [17].

That is why radiologists should be familiar with the various manifestations of the disease.
Findings and procedure details

The presentation is based on analysis of 65 cases of deep pelvic endometriosis. Examinations were performed with 1.5 T MR scanner. Standard imaging protocol includes sagittal, axial and oblique coronal turbo spin-echo T2-weighted images (T2-WI), coronal T2-WI with fat suppression, axial and coronal turbo spin-echo T1-WI with fat suppression before and after intravenous administration of gadolinium chelates (0.2 mmol/kg). Sagittal sequences were acquired with saturation bands placed anteriorly to eliminate the high signal of subcutaneous fat and breath artifacts. Standard protocol is detailed in the Table 1.

Patients were not supposed to eat 3 hours prior MRI and received an antispasmodic drug per os before the examination to reduce bowel peristalsis.

For image analysis we were subdivided the female pelvis and perineum into three standard compartments - anterior, middle and posterior. Endometriotic lesions of the anterior compartment included lesions within vesicouterine pouch, bladder and ureter; lesions of the middle compartment included implants on the serosal surface of the uterus, ovaries, uterine tubes, vagina, broad and round ligaments of the uterus; lesions of the posterior compartment included rectovaginal pouch, uterosacral ligaments, posterior vaginal fornix and rectum.

Typically lesions of deep pelvic endometriosis have poorly defined margins and appeared on T2-WI and T1-WI as a hypointensive mass that represented hypertrophied smooth muscle and fibrous tissue with small hyperintensive on T1- and T2-WI internal foci of ectopic endometrial glands and hemorrhage [20,21,22].

Deep infiltrating endometriosis of the anterior compartment

Deep infiltrating endometriosis of the anterior compartment includes lesions within vesicouterine pouch, bladder and ureter.

Endometriosis of the vesicouterine pouch appears as a hypointense on T2- WI and T1-WI nodular formations with irregular contours between anterior uterine surface and posterior bladder surface (Fig.1), forming an obtuse angle with the bladder wall, which may or may not contain cysts with hemorrhage or not.

Because of the infiltrative growth these lesions may involve a serosal surface of bladder. Sometimes endometriotic lesions may infiltrate the muscular layer of bladder and protrude into the lumen [23]. On MRI bladder endometriosis appears similar to other endometriotic masses as poorly defined nodular lesions within the bladder wall with hypointense signal on T1-WI and T2-WI, including small hyperintensive foci representing ectopic glandular tissue and hemorrhage (Fig.2).
The uterine serosa and uterine ligaments, such as broad and round ligaments, may also be affected by endometriosis (Fig.3,4,5). Endometriosis of the uterine ligaments usually manifests as thickening or nodulation of these structures. Endometriosis affects round and broad ligaments on the right more often than on the left. It can be explained by the presence of the sigmoid colon that prevents retrograde implantation of endometrial glands onto the left round ligament.

In some cases endometriotic lesions may infiltrate one or both ureters. Ureteral endometriosis appears as hypointensive on T1-WI and T2-WI mass with irregular contours and periureteral hypointensive lines - adhesions [24,25,26]. Ureteral dilatation proximal to the endometriotic mass is also a common finding (Fig.6). Ureteral endometriosis is a more severe condition.

**Deep infiltrating endometriosis of the middle compartment.**

Deep infiltrating endometriosis of the middle compartment includes involvement of the uterus, ovaries and fallopian tubes.

Infiltrating endometriosis of the uterus and ovaries appears as small hypointense on T2-WI and hyperintense on T1-WI implants on the uterine serosa and ovarian surface. In cases of non-hemorrhagic content of the implants MRI has a low accuracy in their identifying because of hypointense signal on T1-WI and T2-WI like a normal uterine serosa. Infiltrating endometriosis of the uterus (Fig.7,8) involves uterine serosa in contrast to adenomyosis that involves myometrium.

Endometrial involvement of the fallopian tubes is usually associated with infertility and appears as hypointense adhesions inside slightly dilated tubes (Fig.9,10) [27]. An identifying of endometriosis of fallopian tubes is very difficult without hydrosalpinx.

**Deep infiltrating endometriosis of the posterior compartment**

Deep infiltrating endometriosis of the posterior compartment of the pelvis include involvement of the retrocervical region, rectovaginal pouch, rectum, uterosacral ligaments and posterior vaginal fornix [28,29,30,31].

In deep infiltrating endometriosis of the retrocervical region a retractable retrocervical or retrovaginal nodules with irregular margins are found. Nodules have low signal on T1-WI and T2-WI, may contain simple or hemorrhagic cysts (Fig.11,12).

Retrocervical endometriosis is most commonly associated with rectosigmoid colon and uterosacral ligament involvement [32]. In cases of retrocervical endometriotic lesions
extending to the anterior rectal wall, Douglas pouch obliteration and uterine retroversion may occur due to fibrotic adhesions (Fig.13,14).

The rectosigmoid segment of bowel is most commonly involved by the process, but MRI sensitivity of bowel involvement is very low (about 33%) [15,17,18,19,33]. Rectosigmoid involvement is identified when hypointensive on T1-WI and T2-WI mass is found adhered to the bowel wall, leading to the fixed angulation of the affected segment. In most cases a serosal involvement may be identified and only in few cases lesions erode in the muscularis propria. Disappearance of the fat tissue between the uterus and the rectosigmoid segment and its replacement by a hypointensive tissue with or without hemorrhagic foci with a local thickening of the bowel's wall is marked [29,33,34]. "Mushroom cap" is a specific MRI-sign of rectosigmoid endometriosis; it represents a hypointensive base of the mushroom that attributes to hypertrophy and fibrosis of the muscularis propria and hyperintensive cap that attributes to mucosa and submucosa, which are displaced into the bowel lumen (Fig.14).

In cases of deep infiltrative endometriosis of uterosacral ligament fibrotic thickening of the involved uterosacral ligament is seen (compared with contralateral ligament) with ill-defined contours (Fig.15,16) [27].

Endometriotic lesions on the uterosacral ligament and retrocervical region may extend to the posterior serosa and myometrium - deep infiltrative endometriosis of the posterior uterus, that should not be misclassified as adenomyosis (Fig.17).
Table 1

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Fig. 1: Solid endometriosis of the vesicouterine pouch. Sagittal T2-WI shows a hypointensity mass (arrow) in the vesicouterine pouch.

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**Fig. 2:** Deep infiltrating endometriosis of the bladder. Sagittal T2-WI shows a nodular lesion within the bladder wall with hypointense signal (arrow) and small (1-2 mm) hyperintensive foci represent ectopic endometrial glands.

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**Fig. 3:** Endometriotic lesion in right round and broad ligaments and adjacent uterine serosa. Axial T2-WI shows hypointense mass with irregular contours involving thickened right round and broad ligaments and adjacent uterine serosa (arrow).

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Fig. 4: Endometriotic lesions in left round ligament. Axial T2-WI shows asymmetrical thickened left round ligament (arrow) with hypointense signal and irregular contours.

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Fig. 5: Endometriotic lesions in vesicouterine pouch and left round ligament. Coronal T1-WI after gadolinium injection shows two endometriotic lesions in vesicouterine pouch (arrow) and left round ligament (arrowhead) with irregular contours that are more enhanced than the bladder wall.

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**Fig. 6:** Ureteral endometriosis. Sagittal and coronal T2-WI show hypointensive mass with irregular contours and linear adhesions (arrow). Ureteral dilatation is seen proximal to this mass (arrowhead).

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Fig. 7: Deep infiltrating endometriosis of the uterine serosa with ovarian endometrioma. Axial T2 WI. Hypointense lesion with irregular contours on the uterine serosa (white arrow) and large endometrioma of the left ovarium (black arrows) with hypo- and hyperintensive areas that depend on bloody content.

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Fig. 8: Endometriosis of the uterine serosa. Axial T1-WI. Hyperintense endometriotic lesions on serosa of the posterior uterine wall (arrows).

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Fig. 9: Endometriosis of the left fallopian tube. Oblique coronal T2-WI shows slightly dilated left fallopian tube with fluid content and hypointense adhesions inside (arrows).

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**Fig. 10:** Endometriosis of the left fallopian tube. Sagittal T2-WI shows dilated left fallopian tube and hypointense endometrial tissue with irregular margins surrounds this tube (arrow).

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**Fig. 11:** Deep infiltrating endometriosis of the rectovaginal pouch. Axial T2-WI. Hypointensive endometriotic mass in the Douglas pouch with irregular margins and small hyperintensive foci (arrow) that correspond to the dilated ectopic endometrial glands.

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Fig. 12: Deep infiltrating endometriosis of the rectovaginal pouch. Coronal T1-WI. Hypointensive endometriotic mass in the Douglas pouch with irregular margins and small hyperintensive foci (arrow) that correspond to the bloody content.

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Fig. 13: Retrocervical endometriosis and adenomyosis with uterine retroversion. Sagittal T2-WI shows hypointensive zone of adenomyosis in the posterior uterine wall (white arrow) and heterogenous zone of retrocervical endometriosis (black arrows) with uterine retroversion because of the adhesions.

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**Fig. 14:** Deep infiltrative endometriosis of the bladder, retrocervical region and anterior rectal wall with a Douglas pouch obliteration. Sagittal T1-WI after intravenous injection of contrast medium. Nodular lesions within the bladder wall (arrow) and retrocervical region with hypointense signal and inhomogenous, mainly peripheral, enhancement. "Mushroom cap" sign as a feature of a bowel's endometriosis is seen (arrowhead).

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Fig. 15: Deep infiltrating endometriosis of the right uterosacral ligament and vaginal cuff. Patient after a surgical treatment of retrocervical endometriosis. Axial T2-WI show asymmetrically thickened right uterosacral ligament with irregular margins (white arrow) and heterogenous, mainly hypointensive, mass in a vaginal cuff (black arrow). Postoperative serosocele in the rectovaginal region (asterisk).

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Fig. 16: Deep infiltrating endometriosis of the right uterosacral ligament and vaginal cuff. Patient after a surgical treatment of retrocervical endometriosis. Oblique coronal T1-WI show hyperintensive mass in vaginal cuff representing hemorrhage within fibrous endometrial tissue (arrow).

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**Fig. 17:** Deep infiltrating endometriosis of the retrocervical region and posterior serosa. Oblique coronal T2-WI show hypointensive ill-defined mass in the retrocervical region (black arrow) and asymmetrically thickened left uterosacral ligament with irregular margins (white arrows). Endometriotic lesion on the retrocervical region extends to the posterior serosa (white arrowhead) - deep infiltrative endometriosis of the uterine posterior wall.

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Conclusion

Deep infiltrating endometriosis is a severe gynecologic disorder for which surgery remains the best medical procedure. Adequate treatment requires radical removing of all endometriotic lesions therefore an accurate preoperative assessment of the endometriosis extension is extremely important. MRI is a non-invasive preoperative examination with a high diagnostic accuracy that helps to identify endometriotic lesions to define the surgical strategy. MRI allows to diagnose endometriosis of the bladder, ureters, vesicouterine pouch, round, broad and uterosacral ligaments, rectovaginal pouch, and small implants on the serosal surface of the uterus, ovaries and uterine tubes. The method has a lower sensitivity for rectosigmoid lesions. Radiologists should be familiar with typical MR features and various locations of deep infiltrating endometriosis.
References

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