Preoperative evaluation of adenomyosis and endometriosis with magnetic resonance imaging: examination protocol and typical findings

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Learning objectives

To describe a comprehensive magnetic resonance imaging examination protocol for the preoperative evaluation of the presence and the extent of adenomyosis and/or endometriosis as well as adhesions in case of prior laparascopy or laparotomy. To illustrate typical findings of adenomyosis, endometriosis and adhesions.
Background

Adenomyosis and endometriosis are common gynecological disorders characterized by ectopic endometrium either within the uterine myometrium in case of adenomyosis or outside the uterus in case of endometriosis. Both entities can be the cause for infertility and symptoms like dysmenorrhea or chronic pelvic pain, respectively [1,2]. Despite of those similarities, adenomyosis and endometriosis are deemed to be different disorders and not only different manifestations of the same disease [3], although the term *endometriosis interna* is still in use in the german-speaking countries for adenomyosis [4]. However, independent of the underlying disorder, surgery in most cases remains the therapy of choice to relief symptoms and maintain fertility [2,5]. Preoperative noninvasive testing by magnetic resonance imaging (MRI) has become crucial for planning surgery in both conditions for some reasons: in the case of endometriosis MRI provides a comprehensive overview of the structures within the pelvis and is able to detect even small endometriotic lesions, especially those at subperitoneal sites or hidden by adhesions in patients with prior surgery [6]. When compared to transvaginal and rectal endoscopic sonography, MRI has a better overall performance and is less operator dependent compared to endovaginal ultrasound [6,7]. In the case of adenomyosis MRI also is superior to transvaginal sonography in establishing the diagnosis [8,9] but much less evidence exists supporting its use in the preoperative evaluation before resection of myometrial adenomyomas [5,10]. However, we show one case where MRI correctly predicted the extent and the resectability of one focal adenomyoma (see subsequent Section). Finally, in our experience, the ability of MRI to detect adhesions to the anterior abdominal wall can be of great importance for planning the surgical access.

Therefore, an optimised examination protocol and good knowledge of the possible imaging appearances are mandatory to establish the diagnoses and to describe all details that are of relevance for the surgeon.
Imaging findings OR Procedure details

Patient preparation

Adequate patient preparation is crucial for successful imaging. We do not schedule the examinations with regard to the patients menstruation cycle, since there is no strong evidence that imaging at a certain time during the cycle improves diagnostic accuracy. Patients are asked not to void the bladder in the hour before the examination, since evaluation of the adjacent recesses requires a moderate filling of the bladder. The rectum and the vagina are filled with warmed-up ultrasound gel (150-200 and 50 ml, respectively). Finally, immediately before the examination, an intravenously administered antispasmodic agent, scopolamine-N-butyl bromide (Buscopan®, Boehringer Ingelheim GmbH, Ingelheim, Germany) is administered to reduce motion of the bowel and to attenuate uterine contractions.

Imaging protocol

Our standard imaging protocol includes sagittal, axial, and oblique coronal T2 weighted turbo spin-echo (TSE) sequences, an axial T1 weighted fat-suppressed TSE sequence prior to the intravenous administration of a standard dose of a gadolinium chelate (MultiHance®, Bracco Imaging Deutschland GmbH, Konstanz, Germany). Just prior to and 10 seconds after the start of the injection of the contrast medium, dynamic T1 weighted isotropic fat-suppressed 3D gradient-echo sequences are acquired (4 measurements in total), followed by axial and sagittal T1 weighted fat-suppressed TSE sequences. In case of suspected ureteral involvement, a coronal T1 weighted fat suppressed 3D sequence is acquired. Finally, if the patient has undergone prior abdominal surgery and adhesions are suspected, we perform repeated single slice true fast imaging with steady state precession sequences (TrueFISP) covering the whole abdomen and pelvis in a sagittal and axial orientation with a time resolution of 600 ms during repeated Valsalva maneuver. This technique is described in detail by Lienemann et al. [11].

Imaging findings

Endometriosis

T2 weighted sequences reveal substantial morphologic information of the structures within the pelvis and show pelvic endometriotic lesions as hypointense nodules with irregular or stellate margins due to fibrous tissue and smooth
muscle proliferation as a response to chronic inflammation (Figures 1-4, 7, 10, 12-14, 16-17). If these lesions still contain endometrial glands, they may display intermingled hyperintense spots on T2 weighted images (Figures 1, 4, 10, 13-14). T1 weighted fat-suppressed sequences display these hyperintense foci either as hyperintense or hypointense spots, depending on the presence or absence of blood, respectively (Figures 11 and 15). Endometriotic lesions of the ovaries appear as cystic lesions with bloody content, therefore termed chocolate cysts, with hyperintense signal on T1 weighted images, best depicted with fat-suppression, and with variable signal intensities on T2 weighted images. Those lesions mostly show irregular borders due to adhesions to the surrounding structures as a result of chronic inflammation (Figures 5-10). T1 weighted fat-suppressed sequences after the administration of contrast material may show enhancement of lesions, depending on the degree of inflammation [6].

Adenomyosis

Since this disorder is located at the interface of endometrium and myometrium, a thickening of the junctional zone, which displays as a hypointense band between the hyperintense endometrium and the intermediate myometrium on T2 weighted images, above 12 mm is an important finding which has a high specificity for making the diagnosis. This finding can involve the entire junctional zone in case of diffuse adenomyosis (Figures 18 and 19) or can involve only part of the junctional zone in case of focal adenomyosis (Figure 20). It can be difficult to distinguish focal thickening of the junctional zone from uterine contractions. Another important finding is the presence of submucosal microcysts that appear as hyperintense lesions on T2 weighted images within the junctional zone (Figures 18 and 19). However, microcysts are only present in about half of the cases. A well-delineated focal myometrial mass with hypointense signal on T2 weighted images containing microcysts is termed adenomyoma (Figures 21 and 22). Adenomyoma must be differentiated form leiomyoma, which contain no microcysts [9].

Adhesions

Adhesions may be assumed on the static T2 weighted images when the involved structures cannot be differentiated clearly from each other due to missing fat planes in between them or when fibrotic tissue in between them is present (Figures 23 and 24). However, in many cases these criteria are not clearly present or absent, thus requiring further differentiation. This can be done by using dynamic sequences, which are able to show movement of the involved structures. In case of adhesions, the involved structures will not move away from each other and keep together when the patient is asked to perform repeated Valsalva maneuver (Figures 25 and 26).
Systematic analysis

**Endometriosis**

Dividing the pelvis into defined compartments that can be systematically analysed for the presence of the above mentioned imaging findings is a helpful approach for a thorough evaluation and should therefore be considered.

**Anterior compartment**-The anterior compartment contains the bladder and the urethra. Endometriotic lesions can be located either within the vesicouterine pouch, vesicovaginal septum, bladder wall, and ureter. Figure 1 shows a deep infiltrating endometriosis of the bladder wall. Figures 2 and 3 illustrate a deep infiltrating endometriosis with involvement of the left ureter. In this patient, an impairment of the left kidney function was already present. Detecting ureteral involvement prior to surgery is of great importance, because ureteral stenting can help to identify the ureter during surgery.

**Middle compartment**-The middle compartment comprises the female genital organs, including the ovaries, uterine tubes, uterus, and vagina. Endometriotic lesions therefore can involve these structures as well as the uterine ligaments. Figure 4 shows endometriotic implant involving the left vaginal fornix. Figures 5, 6, and 7 display cystic lesions with bloody content (*chocolate cysts*) within the right ovary and adjacent adhesions. Figures 8 and 9 demonstrate *chocolate cysts* within both ovaries and adhesions to the surrounding structures. Note the displacement of both ovaries, which come to touch each other dorsally to the Uterus. This condition, which can be named *kissing ovaries*, is a result of fibrotic changes of the broad ligaments due to endometriotic implants.

**Posterior compartment**-The central structures of the posterior compartment are the rectosigmoid and its surrounding spaces and fat planes. Thus, endometriotic lesion may involve the rectovaginal pouch (pouch of Douglas), retrocervical area, uterosacral ligaments, posterior vaginal fornix, rectovaginal septum, and rectosigmoid. Figures 10 and 11 show an extensive infiltrating endometriosis within the pouch of Douglas and the retrocervical area. Figure 12 displays a consolidation involving the left uterosacral ligament. Figures 13, 14, and 15 demonstrates an infiltrating endometriotic lesion that involves the right uterosacral ligament, the right vaginal fornix, and the rectum, which in this patient was infiltrated and had to be resected at surgery. Figures 16 and 17 illustrate deep infiltrating endometriotic lesions within the right and left rectovaginal septum. Such deep lesions may be overlooked during laparoscopic exploration.

**Adenomyosis**
Adenomyosis, as mentioned above, can be diffuse or focal or can present as adenomyoma. Figures 18 and 19 illustrate a typical example for diffuse adenomyosis. Figure 20 shows focal adenomyosis. Figures 21 and 22 display adenomyoma within the myometrium. In the latter case, laparoscopic enucleation of the dorsal lesion was successfully performed and the assumed extension of the adenomyoma to the isthmus of the fallopian tube was confirmed at surgery.

Adhesions

Figures 23 and 24 show adhesions between the sigmoid colon and the anterior wall of the uterus, readily displayed on T2 weighted static images. Figures 25 and 26 illustrate adhesions between the anterior abdominal wall in the midline just below the navel and an intestinal loop. In the latter case, the surgeon was aware of this finding and altered the surgical access accordingly.
Fig. 1: Endometriotic involvement of the bladder wall. Sagittal T2 weighted image shows a focal hypointense thickening of the upper bladder wall with tiny intermingled hyperintense foci (arrow).

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**Fig. 2:** Deep infiltrating endometriosis with involvement of the left ureter. T2 weighted images demonstrate a hypointense consolidation with irregular, stellate margins within the left paracervical space (arrow) that involves the left ureter, which is markedly thickened (arrowhead). See also Figure 3.

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**Fig. 3:** Same patient as in Figure 2. Sagittal T2 weighted image better depicts the relative position of the endometriotic lesion (arrow) and clearly shows the dilated ureter (arrowhead).

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**Fig. 4:** Endometriotic lesion of the left vaginal fornix. Axial T2 weighted image shows an hypointense consolidation with irregular and stellate margins containing tiny hyperintense spots (arrow) affecting the left vaginal fornix. Note the fine branches infiltrating the mesorectum (arrowhead) but not the rectal wall.

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**Fig. 5:** Endometriosis of the right ovary. Axial T2 weighted image shows large cysts within the right ovary with an intermediate to hyperintense signal on T2 weighted images (arrows). See also Figures 6 and 7.

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**Fig. 6:** Same patient as in Figures 5 and 7. Axial T1 weighted fat-suppressed image at the same level as in Figure 4 shows hyperintense signal of the cysts (arrows), corresponding to bloody content (chocolate cysts).

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**Fig. 7:** Same patient as in Figure 5 and 6. Note the hypointense consolidations (arrow) adjacent to the endometriotic cystic lesions of the right ovary, which represent adhesions to the surrounding structures.

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**Fig. 8:** Endometriosis of both ovaries. Oblique coronal T2 weighted image shows multiple cystic lesions with heterogeneous signal within both ovaries (arrows). Note the linear hypointense consolidation (arrowhead) between the ovaries and the sigmoid colon above, which represents adhesions between these structures. See also Figure 7.

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Fig. 9: Same patient as in Figure 8. Axial T1 weighted fat-suppressed image at the level of the ovaries displays hyperintense signal of the cysts, corresponding to bloody content (chocolate cysts).

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**Fig. 10:** Endometriotic lesion within the pouch of Douglas and the retrocervical area. Sagittal T2 weighted image shows a extensive hypointense lesion with intermingled hyperintense foci (arrow), which totally obliterates the pouch of Douglas and cannot be differentiated from the retrocervical border. Note also the cystic lesions of the ovaries, representing endometriomas (arrowheads). See also Figure 9.

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**Fig. 11:** Same patient as in Figure 10. Axial T1 weighted fat-suppressed image at the level of the endometriotic lesion within the pouch of Douglas shows multiple hyperintense spots (arrows), which represent focal bleeding.

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Fig. 12: Deep infiltrating endometriosis involving the uterosacral ligament. Axial T2 weighted image shows a focal, slightly hypointense consolidation with irregular and indistinct borders (arrow) involving the left uterosacral ligament (arrowheads).
**Fig. 13:** Deep pelvic endometriosis involving the uterosacral ligament, vaginal fornix, and rectum. Sagittal T2 weighted image shows a focal hypointens consolidation with tiny hyperintense spots and irregular margins (arrow) involving the posterior vaginal fornix (white arrowhead) and the anterolateral rectal wall, which is thickened and contains small hyperintense foci (black arrowhead). See also Figures 14 and 15.

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![Image of pelvic endometriosis](image13)

**Fig. 14:** Same patient as in Figure 13. Axial T2 weighted image better depicts the involvement of the uterosacral ligament (arrow) and the rectal wall (black arrowhead). Note also the involvement of the right vaginal fornix (white arrowhead). See also Figures 13 and 15.

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Fig. 15: Same patient as in Figures 13 and 14. Axial T1 weighted fat-suppressed image at the same level as in Figure 14 shows a tiny hyperintense spot (arrow), which represents focal bleeding.
Fig. 16: Deep infiltrating endometriotic lesions within the rectovaginal septum. T2 weighted images show focal consolidations situated subperitoneally and bilaterally within the rectovaginal septum (arrows). See also Figure 17.

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Fig. 17: Same patient as in Figure 16. Axial T2 weighted image clearly shows the subperitoneal location of the endometriotic implant (arrow) at the top of the rectovaginal septum (arrowhead). Note the considerable amount of ascites within the pouch of Douglas (asterisk).

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Fig. 18: Diffuse adenomyosis. Sagittal T2 weighted image shows a diffuse enlarged uterus. The junctional zone is not visible and multiple submucosal cystic lesions are present that extend from endometrium to markedly thickened myometrium. Note that the endometrium seems to be thickened because of linear straitions that radiate into the myometrium (arrow). This sign is named "pseudowidening of the endometrium".

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Fig. 19: Same patient as in Figure 18. Oblique coronal T2 weighted image adjusted to the longitudinal axis of the uterine corpus again shows the absence of a distinct junctional zone and multiple submucosal cystic lesions with "pseudowidening of the endometrium" (arrow).

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**Fig. 20:** Focal adenomyosis. Sagittal T2 weighted image shows focal thickening of the junctional zone within the dorsal and ventral wall of the uterus (arrows). Note that the junctional zone within the lower apex still is easily visible.

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**Fig. 21:** Adenomyoma. Sagittal T2 weighted images show relatively well outlined lesions within the posterior and ventral wall of the uterus (arrows). Both lesions show a slightly hypointense signal compared to the surrounding myometrium and contain microcysts.

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**Fig. 22:** Same patient as in Figure 21. Axial T2 weighted image better depicts the extension of the adenomyoma (arrow) to the isthmus of the fallopian tube (arrowhead).

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Fig. 23: Visceral adhesions following repeated surgery due to endometriosis. Sagittal T2 weighted image illustrates absent fat plane and thickened fibrotic tissue (arrow) between the anterior wall of the uterus and the sigmoid colon, representing an adhesion between these structures.

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Fig. 24: Same patient as in Figure 23. Axial T2 weighted image again depicts the missing fat plane and the thickened fibrotic tissue between the anterior wall of the uterus and the sigmoid colon, representing adhesion. In this case, diagnosis can easily be made on static images.

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**Fig. 25**: Parietal adhesions involving the anterior abdominal wall and the small intestine. Sagittal TrueFISP image illustrates a suspected adhesion of a bowel loop and the anterior abdominal wall (arrow) in the midline just below the navel due to absent distinct borders.

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Fig. 26: Same patient as in Figure 25. TrueFisp image now during Valsalva maneuver shows a continuous attached bowel loop in exactly the same position (arrow) despite of other bowel loops moving downward. In this case, dynamic sequences add specificity to the diagnosis.

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Conclusion

When adhering to the proposed examination protocol, one is able to diagnose adenomyosis and/or endometriosis and provide comprehensive informations that guide surgical lesion removal in both disorders. Furthermore, in our opinion, it is of great importance to jointly discuss imaging findings in a given patient and also should the radiologist attend surgery in selected cases to better understand the needs of the surgeon.
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References