



Bladder endometriosis: characterization by magnetic resonance imaging and the value of documenting ureteral involvement



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ABSTRACT

Objectives: To characterize bladder endometriosis by MRI and assess aspects of ureteral involvement. **Study design:** From 2007 to 2013, bladder endometriosis was diagnosed, surgically treated and histopathologically verified in 18 patients (mean age 31.7 ± 4.6 years) retrospectively enrolled under a published MRI protocol at our hospital's Endometriosis Center. Preoperatively, to diagnose disease spread, cystoscopy was performed and MRI in the following sequences: T2-TSE and T1-SE with and without fat saturation in the sagittal and transversal planes after rectovaginal opacification. Nine patients additionally underwent a diffusion-weighted sequence, including calculation of the apparent diffusion coefficient (ADC). By consensus, two experienced radiologists, without prior knowledge of the surgical or cystoscopic findings, retrospectively characterized bladder endometriosis on the MRI scans, also determining anatomic position, size, sequence-dependent features and incidence of hemorrhages, and calculating ADC. The scans were also investigated to determine if MRI could detect ureteral involvement intercurrent with bladder endometriosis. **Results:** Endometriosis localizations were bladder roof, $n = 1$ (5.6%) and back wall, $n = 17$ (94.4%). Mean lesion size was 3.65 ± 1.5 ml. Lesions exhibited a lower signal intensity in T2- than in T1-weighted images. High-signal-intensity spots showed an occurrence of 72.2% in fat-suppressed T1-weighted and 61.1% in T2-weighted sequences. Mean ADC was 1251.6 ± 220.9 mm²/s. By MRI, it was not possible to differentiate wall layers and hence infiltration depth. The bladder endometriosis of two women showed direct involvement with the right ureter. Furthermore, one woman had endometriosis of the left distal ureter in addition to bladder endometriosis. All cases of ureteral involvement were detected by MRI.

Conclusions: Characteristic MRI features of bladder endometriosis were found to be low signal intensity in T2-weighted and high-signal-intensity spots in T1- and T2-weighted sequences. Standard-sequence MRI was capable of detecting ureteral involvement, but not bladder wall infiltration depth.

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1. Introduction

Endometriosis is a disease of the uterus in which implants of endometriotic tissue consisting of hormone-dependent glandular formations, stromal cells and smooth muscle are present outside the uterine cavity [1–6]. The literature cites incidence rates of urogenital endometriosis ranging from 0.3% to 15% [7–13]. Approximately 350 cases of bladder endometriosis have been

described [14]. Although the most common localization is the bladder [10], urogenital endometriosis can also affect the ureters, kidneys and urethra.

Alongside manual examination and transvaginal sonography, magnetic resonance imaging (MRI) is becoming a mainstay of preoperative endometriosis diagnostics [15,16]. Initial data on MRI diagnostics for bladder endometriosis show its high accuracy and, particularly, its high negative predictive value [17–20]. Given the lower incidence compared to other localizations, these MRI data are based on small case numbers. To date, the question of whether MRI is capable of preoperatively demonstrating ureteral involvement has not yet been systematically investigated.

This retrospective study aimed primarily to characterize bladder endometriosis morphologically by MRI, but also to determine whether and how MRI is capable of demonstrating

Abbreviations: ADC, apparent diffusion coefficient; DWI, diffusion-weighted imaging; FOV, field of view; HE, hematoxylin and eosin staining; MRI, magnetic resonance imaging; SE, spin echo; TE, echo time; TR, repetition time; TRUFI, true fast imaging with steady precession.

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any ureteral involvement. Our study relied on surgical and histopathological findings as the gold standard.

2. Material and methods

The study was approved by the institutional review board. Prior to inclusion, the patients were presented with comprehensive information about the study. All patients gave their informed written consent to participate.

2.1. Patient population

During the period from 1st January 2007 to 30th June 2013, 2482 women with endometriosis underwent surgical treatment at our endometriosis center. In 25 of these women (1.0%), surgery also encompassed invasive endometriosis of the bladder. In all patients, a medical history was taken followed by clinical rectovaginal examination, transvaginal sonography, cystoscopy and MRI. The surgical biopsies were histopathologically analyzed. Only women who had been examined according to our recently published MRI protocol [20] were enrolled in the study.

In brief, the examinations were performed on a 1.5 Tesla MRI (Magnetom, Avanto, Siemens, Erlangen, Germany) without intravenous contrast medium. To accomplish an optimal filling status of the bladder the patients were requested to empty their bladder 1 h before the examination and then drink 1 l of water. Afterwards, they were not allowed to empty their bladders. Immediately before the examination, 200 ml of water were applied rectally, 10 ml of sterile gel (Instillagel, Farco-Pharma, Cologne, Germany) vaginally and 20 mg of butylscopolamine (Buscopan, Boehringer Ingelheim, German) intravenously. In addition to the described MRI sequence protocol [20], transversal diffusion-weighted sequences (TR 5300 ms, TE 73 ms, b-factors 0, 400 and 600 s/mm², slice thickness 5 mm) were performed and the ADC calculated.

The following exclusion criteria applied: general contraindications against MRI scans (pacemaker, metallic foreign body, claustrophobia), age < 18 years, postmenopausal status, insufficient MRI image quality, lack of vaginal or rectal opacification, lack of patient consent to participate in the study. Finally, 18 patients were enrolled in the study. In total, 7 patients were excluded from the analysis, all of whom had undergone an MRI examination at another institution that did not comply with our study protocol or that was not available.

The mean age of the patients was 31.7 ± 4.6 years (minimum 24 years, maximum 44 years). The time between MRI examination and laparoscopy averaged 10.4 ± 18.7 days (minimum: 1 day, maximum: 56 days). In addition to endometriosis of the bladder, any other laparoscopically and histopathologically demonstrated endometriotic manifestations were documented as well. A systematic correlation between these foci and MRI findings was not the subject of this paper.

Two MRI-experienced radiologists evaluated the scans by consensus (MRI experience of reader 1: 24 years, reader 2: 7 years). Both radiologists were aware that the patients had bladder endometriosis and underwent surgery for it, but both were blinded to any results of manual, sonographic or laparoscopic examinations, and cystoscopy or histopathological studies. The readers evaluated the location of the endometriosis and its size (volume = length × height × width × 0.52). Moreover, the signal intensity of the endometriosis in the T1 and T2 weighting was characterized. The frequency of high-signal-intensity lesions within the endometriosis focus was determined in T1 weighting with fat suppression and in the T2-weighted sequence. Moreover, the readers looked for involvement of the distal ureter where they were supposed to choose between a positive finding (ureteral involvement) or a negative finding (no ureteral involvement).

Involvement of the ureter was defined as involvement of the ureteral orifices and the ureter. Dilatation of the ureter and/or of the kidney collecting system (urinary stasis) was documented.

For conducting this study, patient data were pseudonymized.

2.2. Surgery

The patient was placed under general anesthesia and positioned appropriately. Following disinfection and sterile draping, intra-operative cystoscopy was performed, and the lesion focus, urothelial involvement and localization of the lesion in relation to the ureteral orifices were identified. If necessary, ureteral intubation and/or an indwelling catheter were placed.

Following disinfection of the abdominal surgical field and sterile draping for laparoscopy, the typical pneumoperitoneum was established at 12 mmHg. First, the organs of the mid- and upper abdomen were inspected and secretions from the pouch of Douglas harvested for cytological processing. After the patient was placed in maximum head-down position, the internal genitalia were systemically examined as recently described [20]. Small endometriotic foci were removed prior to partial bladder resection. Both ureters were identified and exposed as appropriate. Complete retrograde filling of the bladder was accomplished with 120 ml fluid. Next, the bladder lesion was grasped with atraumatic forceps (Mahnets) and exposed by dissection on all sides using an Overholt bipolar clamp and scissors up to the muscles of the bladder. Special attention was devoted to the vesicouterine pouch, which had to be dissected safely, was often the deepest point of resection and thus the technical place of least resistance. At the point where it was no longer possible to dissect the endometriotic focus from the bladder, the bladder was opened. Under direct vision of the ostia, the focus was then resected in the healthy tissue using a monopolar needle or a bipolar scissors.

The bladder was closed with seromuscular single over-and-over sutures (2–0 Vicryl) and filled up to 180 ml in a retrograde fashion to check for leak tightness. Next, the bladder focus was removed through an endobag or a mini-Pfannenstiel laparotomy (<4 cm). The surgical field was covered with SprayShield® or Tissuecol® F to prevent adhesion formation. After all instruments were removed and pneumoperitoneum released, and the intervention was completed with proper closure of the incisions.

Postoperatively, the patients received intravenous antibiotics for three days, standardized pain therapy and physiotherapeutic support. On postoperative day 2, renal sonography was performed. The bladder catheter was left in situ for 6 days. Afterwards, cystometry was performed and the bladder catheter removed. The next day, after a sonographic check-up of the residual urine, the patient was discharged for post-inpatient rehabilitation.

2.3. Pathology

As previously described in detail [20], the surgically resected lesions were stained with hematoxylin and eosin for histopathologic studies. Diagnosis of endometriosis was based on proof of ectopic endometrial glands and stroma in the resected lesions [21]. In all cases, the presence of estrogen and progesterone receptors and Ki 67 was verified [22]. Histopathological verification of endometriosis was classified as a positive finding.

2.4. Statistics

Unless otherwise stated, the numbers are expressed as means ± standard deviations or percentages. Laparoscopy with histological verification of the diagnosis for endometriosis was used as the gold standard.

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