Can transvaginal sonography predict infiltration depth in patients with deep infiltrating endometriosis of the rectum?

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BACKGROUND: Patients with deep infiltrating endometriosis (DIE) of the rectum often benefit from surgical treatment, including disc or segmental bowel resection, in terms of pain relief and treatment of infertility. The aim of the present study was to evaluate the diagnostic accuracy of transvaginal sonography (TVS) for preoperative detection of rectal DIE. Furthermore, we aimed to investigate whether TVS can predict infiltration depth based on the distortion of characteristic sonomorphologic features of the rectal wall.

METHODS: Two-hundred patients with symptoms of endometriosis were prospectively assessed by TVS for the presence of rectal DIE before undergoing laparoscopic radical resection of endometriosis including segmental resection of the bowel in affected cases. Sensitivities, specificities, positive and negative predictive values (PPV and NPV), positive and negative likelihood ratios (LHR) and test accuracies were then calculated for the presence of infiltration of the serosal/smooth muscle (S/M) layer and submucosal/mucosal (MUC) layer as demonstrated by TVS and confirmed by histopathological analysis.

RESULTS: Rectal endometriosis was confirmed in 43 out of 195 (22%) cases. The sensitivity, specificity, PPV, NPV, test accuracy and positive and negative LHR of TVS on S/M infiltration were 98%, 99%, 98%, 99%, 99%, 150.24 and 0.02, respectively, whereas respective data on MUC involvement were 62%, 96%, 53%, 97%, 93.8%, 16 and 0.4.

CONCLUSIONS: TVS is a highly valuable tool in detecting rectal endometriosis preoperatively. Within this, S/M endometriotic infiltration can be accurately predicted, whereas TVS is less valuable for detection of MUC involvement.

Key words: counselling / endometriosis / transvaginal sonography / deep infiltrating endometriosis / rectum

Introduction

Endometriosis affects up to 10% of premenopausal women and is defined by growth of endometrial tissue outside the uterine cavity (Melis et al., 1994). Associated symptoms include dysmenorrhea, dyspareunia, dyschezia and infertility and are caused by invasive growth of endometriotic implants. Within this, common sites of pelvic endometriosis include the peritoneum, the ovaries or, in cases of deep infiltrating disease, the uterosacral ligaments (USL), the vagina, the rectovaginal space (RVS) or the rectosigmoid (Brosens et al., 2004). Several epidemiological studies report that the final diagnosis of endometriosis can take up to 8 years from the first occurrence of symptoms (Ballard et al., 2006). One possible reason for the major diagnostic delay and misdiagnosis is the suboptimal primary assessment of pelvic pain patients. As a consequence, several studies have evaluated the diagnostic value of radiological imaging techniques such as computer tomography (CT) (Biscaldi et al., 2007) or magnetic resonance imaging (MRI) (Bazot et al., 2005; Abrao et al., 2007) with a focus on the preoperative evaluation for the presence of deep infiltrating endometriosis (DIE). Within this, several lines of recent evidence report that transvaginal sonography (TVS) also has an important role in detecting DIE of the pelvis, especially in cases of rectal endometriosis. This is of particular interest since CT and MRI are time-consuming, expensive and therefore lack clinical practicability in the primary assessment of pelvic pain patients. The diagnostic value of TVS in the preoperative detection of rectal endometriosis has been demonstrated by Abrao et al. (2007) who compared the use of bimanual examination, TVS and MRI for...
detection of DIE of the rectosigmoid in 104 patients with suspected endometriosis. The authors found a higher diagnostic accuracy for TVS in cases of rectal DIE compared with MRI and clinical examination. Similarly, Bazot et al. (2004) showed that TVS accurately predicted DIE of the rectum or bladder but was less useful in cases of USL, vaginal or RVS involvement. In a subsequent study by the same author, TVS proved more efficient than rectal endoscopic sonography for detection of rectal endometriosis, leading to the suggestion that TVS should be used as the first-line examination in patients with suspected rectal endometriosis (Bazot et al., 2007). Within this, endometriotic infiltration of the rectum predominantly involves the rectal serosa and rectal smooth muscle layer, causing macroscopic thickening and microscopic infiltration of endometrial glands combined with hypertrophy of the smooth muscle layer (Koga et al., 2003). These features are reflected by an irregular thickening and a nodular expansion of the hypoechogenic rectal smooth muscle layer on TVS, covered by a hyperechogenic rim corresponding to the rectal submucosa and mucosa as demonstrated by studies using TVS combined with water-contrast enema of the rectum (Koga et al., 2003). The focus of the present analysis was to further evaluate the diagnostic accuracy of TVS for preoperative diagnosis of rectal endometriosis in pelvic pain patients without prior bowel preparation in the outpatient setting. Furthermore, we aimed to investigate whether TVS can predict infiltration depth of rectal wall layers defined by characteristic morphological changes of the rectum on TVS.

Materials and Methods

Two-hundred consecutive patients who presented to our pelvic pain clinic from September 2007 until June 2008 with symptoms suggestive of endometriosis, i.e. dysmenorrhea, dyspareunia, chronic pelvic pain, dyschezia or subfertility following the exclusion of male factors and ovulation disorders (Table I), were booked for diagnostic laparoscopy and laparoscopic resection of all visible endometriotic lesions. All patients were prospectively submitted to TVS ≤2 months prior to laparoscopy. Patients with laparoscopic confirmed bowel endometriosis were treated with segmental resection of the rectosigmoid and, if necessary, dissection of the pouch of Douglas (POD) and RVS which, combined with histological confirmation of endometriosis, was considered the gold standard of definitive diagnosis of endometriosis. TVS was performed by the same examiners (G.H. and J.K.) with extensive experience in TVS for DIE. Only patients with an available complete past medical, social, obstetrical and gynaecological history and the patient’s consent were included in the present analysis. Patients with a history of gynaecological cancer, previous surgery for DIE involving rectal surgery and/or dissection of the POD or RVS or patients with a history of rectal resection for other causes were excluded from this analysis. In addition, virgins were excluded since TVS will not be performed in these patients. The study was approved by the Institution Review Board and informed consent was obtained from all patients enrolled in this study.

Transvaginal sonography

TVS was either carried out with a Logic 9 (GE) or an Accuvix XQ (Accuvis) scanner using a 5–9 MHz transducer for transvaginal visualization of the pelvic organs and the rectosigmoid. All examinations were performed during the initial consultation and none of the patients received bowel preparation prior to performing TVS. In order to achieve adequate visualization of the rectum, the probe was introduced beyond the introitus and guided in up and down movements to visualize the rectosigmoid and the anatomical layers (Fig. 1A), i.e. rectal smooth muscle layer as well as rectal submucosa/mucosa (MUC) up to a level of ~3–4 cm above the uterine fundus. In accordance with the ultrasonographic features for endometriotic infiltration of the rectal wall layers (muscularis and MUC) as described by Koga et al. (2003) and based on our own observations (unpublished data), normal, physiologic rectal wall anatomy does appear on TVS as follows: the rectal smooth muscle layer can be visualized as a regular, hypoechogenic line with a thickness of ~2 mm. In contrast, rectal submucosa and mucosa do appear distal to the probe, i.e. luminal, as a regular, hyperechogenic line with 1–2 mm in diameter (Fig. 1B and C). This is followed by irregular, hyper and/or hypoechogenic structures corresponding to the bowel contents in the unprepared patient. On the basis of the anatomy and thickness of the rectal serosa (~0.5 mm in diameter), serosal tissue cannot be visualized on TVS. In accordance with previous reports (Dessole et al., 2003; Koga et al., 2003; Bazot et al., 2007; Menada et al., 2008) and our own observations (unpublished data), sono graphic features of endometriotic disease of the rectosigmoid with endometriotic infiltration confined to the serosal/smooth muscle (S/M) layer were defined by the presence of a regular or irregular hypoechogenic mass ≥3 mm distorting and/or replacing the normal appearance of the smooth muscle layer (Fig. 2A and B) combined with the presence of a continuous hyperechogenic rim reflecting the intact MUC. DIE additionally involving the submucosal and mucosal layer, thereby infiltrating all rectal wall layers, was defined by additional disruption or complete absence of the hyperechogenic rim corresponding to the rectal MUC layer (Fig. 3A and B).

Laparoscopy, radical resection of endometriosis and histology

Diagnosis of bowel endometriosis was based on visualization and radical resection of areas showing signs of macroscopic endometriotic involvement followed by histological confirmation defined as the presence of ectopic endometrial tissue, i.e. glandular and stromal structures on light microscopy (Clement, 2002). All cases of complete obliteration of the POD secondary to endometriosis were cleared surgically in order to achieve full resection of disease and to adequately assess the extent of endometriotic infiltration of structures, such as the lower rectum, vagina or RVS. All cases of rectal endometriosis were treated with segmental resection of the bowel followed by side-to-end or end-to-end anastomosis.

Table I  Symptoms in 200 patients undergoing TVS for DIE of the rectum followed by radical resection of endometriosis confirmed by histopathological analysis

| Patient age (years, median, range) | 33 (16–45) |
|-----------------------------------|------------|
| Symptom                           | Cases (n, %) |
| Dysmenorrhea                      | 155 (77.5) |
| Dyspareunia                       | 69 (34.5)  |
| Dyschezia                         | 29 (14.5)  |
| Dysuria                           | 4 (2)      |
| Chronic pelvic pain               | 44 (22)    |
| Subfertility                      | 34 (17)    |
| Total patient number              | 200 (100)  |
Statistical analysis

Sensitivity, specificity, positive and negative predictive values (PPV and NPV), test accuracy and positive and negative likelihood ratios (LHR) and corresponding confidence intervals (CI) of TVS for possible endometriotic infiltration of the S/M layer and the rectal MUC were calculated with CatMaker statistical software.

Results

Patients, surgical and histological findings

Patient’s symptoms and characteristics are depicted in Table I. All 200 patients were subjected to TVS followed by laparoscopy and radical resection of all visible areas exhibiting macroscopic signs of endometriosis. Patients with obstruction of the POD were primarily treated with complete dissection of the occluded pouch followed by radical resection of DIE if present. Patients exhibiting endometriosis of the rectosigmoid were treated with segmental resection of the rectum followed by side-to-end anastomosis. Within this, resection specimen was only regarded positive for presence of disease following histological confirmation of endometriosis as described by Clement (2002). Five out of 200 patients were excluded from the final analysis. Three out of 200 patients opted against bowel surgery for DIE of the rectum. Furthermore, histological analysis was inconclusive (i.e. no definitive diagnosis on the presence of MUC involvement) in another two cases leaving 195 patients for the final analysis. As depicted in Table II, DIE of the rectum was diagnosed by laparoscopy and histological analysis in 43 out of 195 (22%) patients. Within this, isolated serosal endometriotic involvement was diagnosed in 2 out of 195 (1%) patients, whereas infiltration of the serosal and rectal smooth muscle layer was found in 28 out of 195 (14%) cases. Involvement of all rectal layers (serosa, smooth muscle and the MUC layer) was confirmed in 13 out of 195 (7%) patients with rectal DIE.

TVS findings

DIE invading the S/M layer of the rectum was diagnosed via TVS in 41 out of 195 (21.0%) women with one false-positive and one false-negative result. The patient with the false-positive result showed discrete rectal adhesions to the posterior uterine wall without signs of endometriosis during laparoscopy. The false-negative patient exhibited DIE of the upper third of the rectum not visualized by TVS. Additional infiltration of the MUC layer, i.e. involvement of all rectal wall layers was detected by TVS in 15 out of 195 (7.7%) patients with seven false-positive and five false-negative results. On macroscopic and histological analysis, all false-positive cases showed infiltration of the rectal wall exclusively confined to the S/M layer, whereas false-negative cases exhibited involvement of the submucosa on macroscopic and histological analysis.

Data on sensitivity, specificity, NPVs, PPVs, test accuracies and positive and negative LHR and corresponding CI for TVS predicting the presence and the extent of endometriotic infiltration of rectal wall layers are shown in Table III.

Figure 1 (A) Macroscopic appearance of rectal wall layers (rectal smooth muscle layer, S/M; rectal submucosa/mucosa, MUC). (B) Sonographic appearance of normal rectal wall layers on TVS: the rectal serosa and smooth muscle layer appear as a thin, hypoechoic line (**) covered by the rectal submucosa and mucosa (*) which can be visualized as a hyperechoic rim covering the rectal smooth muscle layer (C, cervix; B, anterior rectal wall). (C) Schematic TVS appearance of the normal rectal wall layers (**rectal S/M layer, *rectal MUC) and sonomorphological changes caused by infiltration of endometriotic tissue confined to the rectal smooth muscle layer (**), which is associated with thickening and hypertrophy of the smooth muscle layer covered by an intact MUC layer (*).
Discussion

On the basis of the chronic and progressive nature of endometriosis and its associated symptoms, patients often benefit from early diagnosis and adequate therapy. In order to achieve persistent relief of symptoms and to alter spontaneous or assisted conception rates, radical surgical therapy including partial resection of the vagina, the bladder or the rectum has proved highly beneficial in patients with DIE in terms of pregnancy rates and reduction of pain scores (Sutton et al., 1997; Redwine and Wright, 2001; Jones and Sutton, 2002; Olive and Pritts, 2002; Keckstein et al., 2003; Lyons et al., 2006). Nevertheless, radical surgical resection of rectal endometriosis remains an issue of constant debate since long-term data on the outcome of bowel resection for DIE are limited (Keckstein et al., 2003; Ford et al., 2004, 2005; Darai et al., 2005, 2007). In addition, several surgical techniques for the treatment of rectal DIE have been described including segmental resection, disc resection of endometriotic nodules and isolated resection of endometriotic tissue dependent on the amount of infiltration into rectal wall layers, better known as ‘rectal shaving’. Adequate primary assessment of patients with suspected DIE of the bowel is therefore pivotal in order to reduce the diagnostic delay and to discuss the possible treatment options with the patient. In cases where surgical resection of rectal endometriosis is considered, preoperative detection and estimation of the extent of DIE enables the surgeon to plan surgical treatment strategies. Within this, the depth of endometriotic infiltration is an important factor since superficial serosal disease or minor involvement of the muscular layer may be amenable for shaving or limited disc resection procedures, whereas cases of extensive involvement of all rectal wall layers might be

![Figure 2](A) TVS demonstrating a solid hypoechoic nodularity behind the uterine cervix (C) arising from the anterior rectal wall (B), corresponding to DIE confined to the S/M layer (**) with an intact MUC layer (*). The continuous appearance of the hyperechogenic rim (*) reflects the intact rectal MUC. (B) Corresponding (Fig. 2A) bowel specimen of rectal DIE exclusively affecting the S/M layer (**) without signs of infiltration of the MUC layer (*).

![Figure 3](A) TVS demonstrating a solid hypoechoic nodularity behind the uterine cervix (C) arising from the anterior rectal wall (B), corresponding to DIE affecting the serosal and rectal smooth muscle layer (**) with an additional infiltration of the MUC layer (arrows). In contrast to Fig. 2A, the continuous appearance of the hyperechogenic rim (*) is interrupted by hypoechogetic foci arising from the underlying infiltrated muscular layer reflecting endometriotic infiltration of the rectal MUC (arrows). (B) Corresponding (Fig. 3A) bowel specimen of rectal DIE of the S/M layer (**) with additional infiltration of the MUC layer (arrows) in proximity to the intact MUC (*)

### Table II Anatomical location of DIE of the rectum diagnosed by radical resection and histopathological analysis in 43 out of 195 patients with suspected endometriosis

| DIE of the Rectosigmoid | Cases (n, %) |
|-------------------------|-------------|
| Serosa (S)              | 2/195 (1)   |
| S + Muscularis (M)      | 28/195 (14) |
| S + M and Mucosa (MUC)  | 13/195 (7)  |
| Total number            | 43/195 (22) |
considered for more extensive surgery such as segmental resection. Although some authors have investigated the diagnostic value of TVS for detecting rectal endometriosis preoperatively (Koga et al., 2003; Bazot et al., 2004; Abrao et al., 2007), data on the estimation of infiltration depth are sparse. Menada et al. (2007) recently investigated 90 endometriosis patients with bowel preparation (saline solution) followed by TVS with rectal endosonography for preoperative detection of rectal endometriosis. TVS correctly identified the presence of rectal infiltration reaching at least the muscular layer in only 56.5% (13 out of 23 cases) of patients with rectal DIE. The aim of the present study was to extend these preliminary observations and to investigate the value of TVS in predicting the infiltration depth of endometriotic nodules invading the rectal wall in the outpatient setting, i.e. without prior bowel preparation. Following the sonomorphologic criteria for endometriotic infiltration of the rectal smooth muscle layer and distortion of the sonographic appearance of normal rectal MUC, TVS yielded a specificity, sensitivity, PPV and NPV of 98%, 99%, 98% and 99% for detecting infiltration of the smooth muscle layer. In contrast, the corresponding values for mucosal involvement were 62%, 96%, 53% and 97%. These results underline the diagnostic value of TVS in diagnosing rectal endometriosis preoperatively. On the basis of our observations, involvement of the smooth muscle layer can be accurately determined by TVS in the large majority of patients with suspected DIE but appears to be of little clinical value in detecting the infiltration of all rectal wall layers, i.e. infiltration of the MUC. As a consequence, the preoperative use of TVS not only confers the potential to adequately counsel the patient with positive TVS findings about the potential risks and benefits of bowel surgery, but also enables the surgeon to indicate and plan the surgical procedure such as segmental resection more precisely. However, the decision on whether or not to perform shaving procedures—which may be applicable to small unilocular nodules confined to the S/M layer—should not be based on preoperative TVS findings.

Taken together, we suggest that TVS should be used as the primary method for the preoperative assessment of patients with possible DIE of the rectum. The inclusion of TVS in standardized subspecialist training programs of future gynaecologists dealing with endometriosis will increase the ability to reproduce these findings and the quality of primary assessment of pelvic pain patients. Information on the presence of rectal endometriotic disease may influence the surgical treatment approach in these patients.

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### Table III  Sensitivity, specificity, PPV, NPV, accuracy and positive and negative LHR and corresponding CI for preoperative detection of endometriosis of the rectum and depth of endometriotic infiltration by TVS in 195 patients with suspected endometriosis

| Localization | Sensitivity (%) | Specificity (%) | PPV (%) | NPV (%) | Accuracy (%) | +ve LHR | −ve LHR |
|--------------|----------------|----------------|---------|---------|--------------|---------|---------|
| M            | 98 (40/41)     | 99 (153/154)   | 98 (40/41) | 99 (153/154) | 99 (193/195) | 150.24  | 0.02    |
| CI           | 93–100         | 98–100         | 93–100   | 98–100  | –            | 21.3–1060.5 | 0.00–0.17 |
| MUC          | 62 (8/13)      | 96 (175/182)   | 53 (8/15) | 97 (175/180) | 94 (183/195) | 16      | 0.4     |
| CI           | 35–88          | 93–99          | 28–79   | 95–100  | –            | 6.9–37.2 | 0.2–0.8  |

DIE of the rectum was finally diagnosed by laparoscopy, radical resection and histological confirmation of endometriosis in 43 out of 195 patients. PPV, positive predictive value; NPV, negative predictive value; +ve LHR, positive likelihood ratio; −ve LHR, negative likelihood ratio.
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