

Transvaginal ultrasonography with bowel preparation is able to predict the number of lesions and rectosigmoid layers affected in cases of deep endometriosis, defining surgical strategy

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BACKGROUND: Successful surgical treatment of deep bowel endometriosis depends on obtaining detailed information about the lesions, prior to the procedure. The objective of this study was to determine the capability of transvaginal ultrasonography with bowel preparation (TVUS-BP) to predict the presence of one or more rectosigmoid nodules and the deepest bowel layer affected by the disease.

METHODS: A prospective study of 194 patients with clinical and TVUS-BP suspected deep endometriosis submitted to videolaparoscopy. Image data were compared with surgical and histological results.

RESULTS: With respect to bowel nodule detection and presence of at least two rectosigmoid lesions, TVUS-BP had a sensitivity of 97 and 81%, specificity 100 and 99%, positive predictive value (PPV) 100 and 93% and negative predictive value (NPV) 98 and 96%, respectively. Regarding diagnosis of infiltration of the submucosal/mucosal layer, TVUS-BP had a sensitivity of 83%, specificity 94%, PPV 77%, NPV 96%.

CONCLUSIONS: These findings show that TVUS-BP is an adequate exam for evaluating the presence of one or more rectosigmoid nodules and the deepest layer affected in deep infiltrating bowel endometriosis, confirming the importance of this technique for defining the most appropriate surgical strategy to be implemented.

Key words: endometriosis / bowel / ultrasonography / laparoscopy / diagnosis

Introduction

Endometriosis is one of the most common diseases in gynecology. One of the principal challenges involved in managing endometriosis is obtaining information that may both assist in deciding whether laparoscopy is required, and permit the specialist to select the optimal surgical strategy, prior to surgery (Abrao *et al.*, 2007; Goncalves *et al.*, 2009). This assumes particular importance in cases of deep endometriosis, which not only represents the most symptomatic form of the disease, but also the form for which surgical treatment is most complex, principally when the bowel is affected (Cornillie

et al., 1990; Abrao *et al.*, 2008a). With the development of non-invasive diagnostic resources, more cases of bowel endometriosis have been diagnosed. The correct decision regarding how to manage the surgical treatment of such patients is fundamental, options include shaving, nodule resection or segmental resection of the rectum affected by the disease (Abrao *et al.*, 2008a).

Currently, the best diagnostic resources available are imaging methods (Abrao *et al.*, 2004; Chapron *et al.*, 2004; Bazot *et al.*, 2008). When deep endometriosis affecting the rectosigmoid is clinically suspected, whether or not in association with lesions in other areas of the pelvis, it is fundamental to perform an adequate

imaging exam capable of indicating whether one or more lesions are present, the size and depth of the lesion(s) and the distance between the lowest lesion and the anal verge (Chapron *et al.*, 2004; Goncalves *et al.*, 2009). With this information, it is then possible to define the treatment option to be implemented, bearing in mind that, when medical therapy fails in relieving painful symptoms, the most comprehensive surgical procedure is an adequate form of pelvic pain management, improving patient's quality of life and reducing recurrence rates of the disease, a situation generally confused with the persistence of lesions following incomplete surgical procedures (Kavallaris *et al.*, 2003; Garry *et al.*, 2000; Remorgida *et al.*, 2005; Vignali *et al.*, 2005; Dubernard *et al.*, 2006).

The imaging exams capable of providing these data are: transvaginal ultrasonography (Bazot *et al.*, 2003, Abrao *et al.*, 2007; Menada *et al.*, 2008; Guerriero *et al.*, 2008), transrectal ultrasonography (Chapron *et al.*, 1998; Koga *et al.*, 2003), endoscopic transrectal ultrasonography (Bazot *et al.*, 2003; Abrao *et al.*, 2004), magnetic resonance imaging (Abrao *et al.*, 2007, Bazot *et al.*, 2008), multislice computed tomography (Biscaldi *et al.*, 2007) and barium enema (Ribeiro *et al.*, 2008). All these methods have been evaluated with respect to their applicability in defining the above-mentioned questions.

The objective of the present study was to evaluate the use of a specific protocol consisting of transvaginal ultrasonography with bowel preparation (TVUS-BP) to determine the number of endometriotic lesions affecting the rectosigmoid and the depth of these lesions in the bowel wall.

Materials and Methods

Between October 2006 and September 2008, 194 consecutive patients were submitted to laparoscopy at this institute on a suspicion of endometriosis. All patients underwent TVUS-BP, and statistical analysis was done to calculate the capability of this method in the detection of one or more rectosigmoid endometriotic lesions, using surgery and histology as gold standard comparison methods. Of these 194 patients, there were clinical and image (TVUS-BP) indicators suggestive of bowel endometriosis in 81 cases, and the surgical treatment in these women was rectosigmoidectomy, disc resection or shaving. The capability of TVUS-BP in establishing the deepest layer of the rectosigmoid affected by the disease was verified, but in this analysis data from only 67 patients, who had been submitted to resection of a bowel segment, were included. Only cases of resection were used in this analysis, to confirm the deepest layer affected with histological information.

Bowel resection was indicated when the patient complained of incapacitating pelvic pain, cyclic bowel alterations, such as pain on evacuation and/or cyclic anal bleeding, associated with ultrasonographic signs of rectal infiltration of the deep muscularis propria, submucosal or mucosal layers of the rectum and/or sigmoid (Abrao *et al.*, 2007). The study was approved by the Internal Review Board of the institute.

Women scheduled to undergo surgery for the therapeutic management of endometriosis were included; exclusion criterion was having been submitted to any prior bowel surgery.

Before undergoing transvaginal ultrasonography, all patients carried out bowel preparation by taking an oral laxative on the eve of the exam (5.0 mg of sodium picosulfate) and using a rectal enema (120 ml of sodium diphosphate) within an hour before initiation of exam, to eliminate any fecal residue and gases present in the rectosigmoid (Abrao *et al.*, 2007; Goncalves *et al.*, 2009). Each examination was interpreted in real-time and documented in printed photographs. All exams were performed by the

same radiologist (MOG), who was blinded with respect to the clinical data and the results of the other exams to which the patient had been submitted. The scanners used for the exams were the HDI 5000 and the Envisor (Phillips Medical System, Eindhoven, Netherlands) connected to a 5–9 MHz transvaginal transducer.

All the exams were carried out according to the same procedure: after the transducer was introduced transvaginally, it was maintained at an angle of 30–60°, in the antero-posterior axis, and the rectum (lower, mid and upper) was examined, followed by the sigmoid (Fig. 1) as far as it was possible to go (normally 30–40 cm from the anal verge).

The present study evaluated the presence of at least two rectosigmoid lesions versus only one intestinal lesion diagnosed by TVUS-BP in comparison to surgery and histology. Also the deepest layer of the bowel affected by endometriosis was evaluated.

Bowel involvement was established when a long, nodular, predominantly solid, hypoechogenic lesion adhered to the wall of the intestinal loop was detected. The degree of infiltration varied, beginning at the outer part of the muscularis propria but at times penetrating as far as the submucosal/mucosal layer. The longitudinal, anteroposterior and transverse axes of the lesions were measured. The various layers of the wall were examined in detail (Fig. 2), beginning at the outer layer and continuing towards the inner layers: the serosal layer (thin hyperechoic line); the two layers, internal and external, of the muscularis propria (two hypoechoic strips separated by a fine hyperechoic line); the submucosal layer (hyperechoic); the muscularis mucosa (hypoechoic) and the interface between the lumen and the mucosal layer (hyperechoic).

In few cases, bowel serosa alone is affected, usually when a retrocervical, paracervical or torus uterinus lesion is adhered to the rectosigmoid. It can have either just a point of contact or a small hyperechoic area, a few millimeters thick in the bowel external surface, without compromising the muscularis layer.

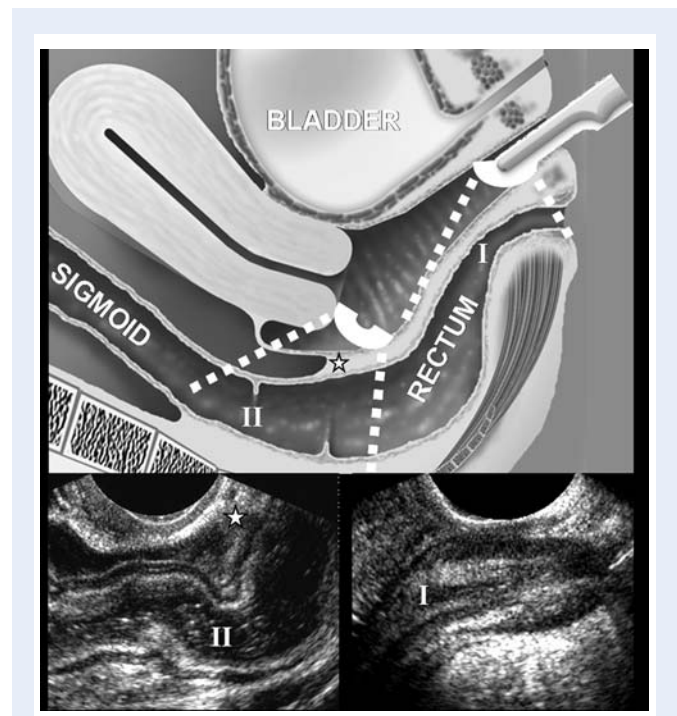


Figure 1 Picture and TVUS-BP with the main rectum anatomical references. Peritoneal reflection (star), 7 cm above the anal verge (AV). First and second curve of rectum, 3.0 cm (I) and 8 cm (II) above AV, respectively.

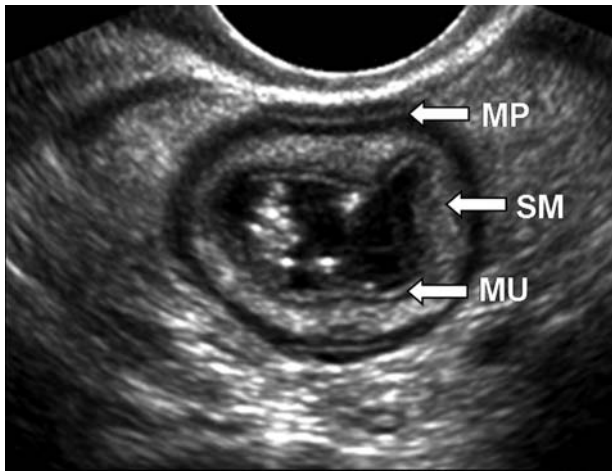


Figure 2 TVUS-BP. Normal bowel layers: muscularis propria (MP), submucosal (SM) and mucosal (MU).

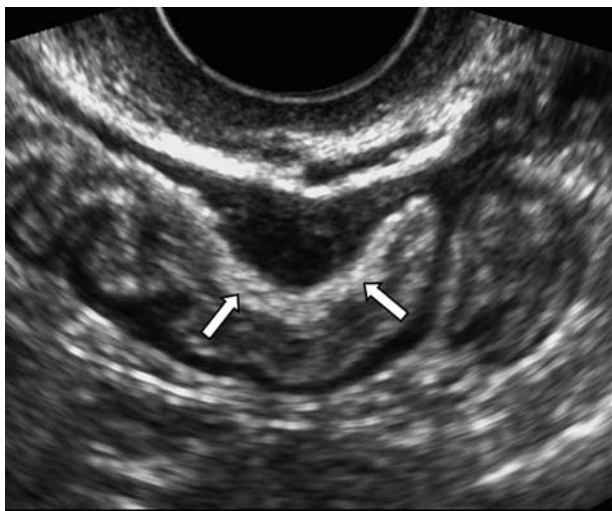


Figure 3 TVUS-BP showing a solid hypoechoic nodule infiltrating the muscularis propria layer of the sigmoid. The submucosal layer is unaffected (arrows).

We consider that there is deep intestinal endometriosis when the lesion affects at least the muscularis propria layer. The criterion used to predict whether the lesion had infiltrated up to at least the muscularis propria was the existence of a nodule or hypoechoic, irregular thickening of this layer in the segment, irrespective of whether the hyperechoic strip that separates the external from the internal muscularis propria was interrupted (Fig. 3). To determine whether infiltration of the submucosal layer had occurred, the criterion used was the existence of hypoechoic tissue originating in the serous layer and the muscularis propria, causing partial or total interruption of the hyperechoic line corresponding to the submucosal layer (Fig. 4). The submucosal and mucosal layers were considered as a single layer, the submucosal/mucosal layer, since this would have no impact on the decision made regarding therapy or on planning the surgical procedure.

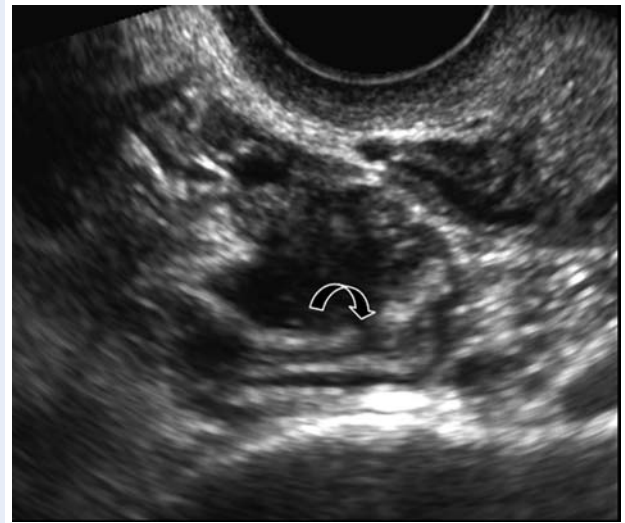


Figure 4 TVUS-BP showing an irregular, solid, hypoechoic nodule infiltrating the muscularis propria and submucosal layers of the rectum. Note that the hyperechoic line of the submucosal layer is interrupted by the lesion (curved arrow).

The patients underwent videolaparoscopy for treatment of the disease within 3 months of the imaging exam. Endometriosis was classified according to the American Society for Reproductive Medicine revised classification of the disease (1996) and surgery was performed by the same team in all cases. The double-stapling technique was used to resect the bowel segment, a linear stapler being used to remove the portion and a circular stapler to perform bowel anastomosis.

Surgical specimens were evaluated by a single pathologist who reported on the same variables described in the imaging exam: the number and dimension of the lesions and the bowel layer affected.

Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), accuracy and 95% confidence intervals were calculated, as well as positive and negative likelihood ratios (LR+ and LR-) for each of the non-invasive diagnostic TVUS-BP findings and compared with surgical and histological findings, which were considered the gold standard.

Results

One hundred and ninety four patients submitted to TVUS-BP followed by laparoscopy were evaluated. The mean age of patients was 34.2 ± 4.9 years and the mean time between the onset of symptoms and diagnosis was 5.2 years (range 0.4–10 years). The most frequent clinical complaints reported by the patients were: severe or incapacitating dysmenorrhea in 56% (109/194), deep dyspareunia in 62% (120/194), cyclic bowel complaints in 58% (112/194), chronic pelvic pain in 20% (39/194), infertility in 50% (97/194) and cyclic urinary complaints in 9% (18/194).

According to the 1996 classification of the American Society for Reproductive Medicine (ASRM), 63% (123/194) of the patients had stage III or IV endometriosis, with lesions simultaneously affecting other areas of the pelvis, as shown in Table I. In patients with recto-sigmoid endometriosis, the incidence of advanced stages (III or IV) was higher, reaching 94% (76/81).

Deep endometriosis of the rectum and/or sigmoid was confirmed by histology. Rectosigmoid nodules measurement was performed only in the cases of bowel resection. The longitudinal axis of the nodules in relation to the intestinal loop was the largest axis in every case, varying

Table I Surgical characteristics of the 194 patients included in the study

Staging (ASRM, 1996) and site affected by endometriosis	Number of patients (%)
Stage I/II	71 (37%)
Stage III/IV	123 (63%)
Ovary	105 (54%)
Retrocervical	112 (58%)
Rectosigmoid	81 (42%)
Vagina	20 (10%)
Ureter	10 (5%)
Bladder	12 (6%)
Appendix	10 (5%)

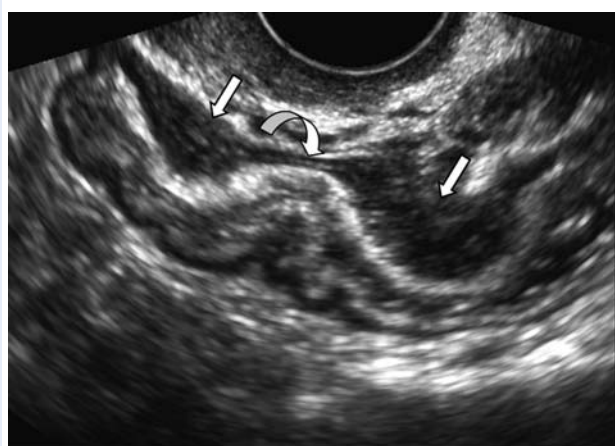


Figure 5 TVUS-BP showing two nodules of deep endometriosis (arrows) in the same segment of the rectosigmoid. The curved arrow shows the normal wall between the nodules.

from 1.1 to 6.3 cm in length [mean 3.0 ± 5.8 cm (SD)]. Thickness varied from 0.3 to 2.3 cm (mean 1.1 ± 1.2 cm) and the transverse axis ranged from 0.6 to 6.0 cm (mean 2.3 ± 1.5 cm). With respect to the circumference of the loop affected by endometriosis, the percentage affected was also calculated histologically and found to vary from 10 to 100%, with a mean of 55%. Transvaginal ultrasonography with prior bowel preparation successfully diagnosed the presence of deep bowel endometriosis in 79 out of 81 patients, with a sensitivity, specificity and accuracy of 97, 100 and 99%, respectively, and a likelihood ratio for a negative result (LR⁻) of 0.02 (0.01–0.10) and a LR for a positive result not applicable. There were two false negative results and no false positive case.

With respect to the number of lesions in the rectosigmoid, in 60% of the patients (49/81) one single nodule was present, although in 40% (32/81) at least two foci were found at surgery and histology. A total of 123 lesions were found in 81 patients with deep intestinal endometriosis, corresponding to an overall mean of 1.5 nodules per patient. TVUS-BP correctly diagnosed multiple foci (Fig. 5) in 26 of these 32 patients, with sensitivity, specificity and accuracy of 81, 99 and 96%, respectively, and a likelihood ratio for a positive result (LR⁺) of 65.81 (16.44–263.53), and a LR⁻ of 0.19 (0.09–0.39) (Table II).

In two patients, ultrasonography overestimated the number of lesions (two false-positives). Of the six false-negatives, there were four cases in which the result did not affect surgical strategy because the nodules were situated in the same bowel segment and the distance between them was <2 cm. In one case, however, the second lesion was inaccessible by ultrasonography since it was situated in the proximal sigmoid and there was a large ovarian cyst between the transducer and the nodule.

Data of 180 patients were used to achieve TVUS-BP accuracy in the diagnosis of the lesion depth in the bowel wall and 67 of them were submitted to rectosigmoid segment resection and histological analysis of the surgical specimens (endometriotic nodules). We excluded 14 patients from the sample, who had a deep intestinal lesion without histological proof because the surgical procedure (nodule resection) did not include the entire intestinal segment affected by the disease. In 54% of the patients that had deep bowel endometriosis (36/67), endometriotic nodules had infiltrated the submucosal or mucosal layer. In all 67 cases, TVUS-BP successfully detected that the lesion had infiltrated at least as far as the muscularis propria (sensitivity and accuracy of 100%, both with a 95% CI of 93.2–100%). With respect to infiltration of the submucosal/mucosal layer,

Table II Analysis of the information that TVUS-BP is able to offer with respect to lesions of deep endometriosis of the rectum and sigmoid

	Sensitivity	Specificity	PPV	NPV	Accuracy
Rectosigmoid lesion detection	97% (79/81)	100% (113/113)	100% (79/79)	98% (113/115)	99% (192/194)
95% Confidence interval	90.5–99.6	95.9–100	94.2–100	93.2–99.7	96.6–99.9
Presence of at least two rectosigmoid lesions	81% (26/32)	99% (160/162)	93% (26/28)	96% (160/166)	96% (186/194)
95% Confidence interval	63.0–92.1	95.1–99.8	75.0–98.8	91.9–98.5	91.7–98.1
Lesions affecting the submucosal/mucosal layer of the bowel	83% (30/36)	94% (135/144)	77% (30/39)	96% (135/141)	92% (165/180)
95% Confidence interval	66.5–93.0	88.1–96.9	60.3–88.3	90.6–98.3	86.4–95.1

TVUS-BP correctly diagnosed 30 of the 36 cases, resulting in sensitivity and specificity of 83 and 94%, respectively. TVUS-BP overestimated the depth of the nodule in nine cases and underestimated it in six, resulting in accuracy of 92%, with a LR+ of 13.33 (6.97–25.52), and an LR– of 0.18 (0.09–0.37).

Of the 194 patients, there was seven in whom bowel serosa was affected by endometriotic lesions, detected during the surgery. As mentioned before, these cases were not considered as deep endometriosis lesions in the rectosigmoid. Concerning these lesions, TVUS-BP was correct in five lesions, characterizing sensitivity, specificity and accuracy of 71, 100 and 99%, respectively, with a LR– of 0.29 (0.09–0.92) and a LR+ not applicable. There were two false negative results and no false positive. Surgical observation and not histology is the main limit of this data.

Discussion

Deciding on whether endometriosis requires surgical treatment depends on many factors, such as symptoms, physical examination, age of the patient, her reproductive expectations and the sites affected by the disease. In order to plan adequately, a precise pre-operative evaluation should ideally be carried out, enabling appropriate preparation of the entire multi-professional team required for the procedure and permitting the physician to discuss the risks involved with the patient, thereby ensuring that she is accurately informed (Duepree *et al.* 2002; Darai *et al.*, 2005; Remorgida *et al.*, 2007; Abrao *et al.*, 2008b).

Of all the sites that may be affected by deep endometriosis, the bowel in particular requires well-defined planning that should include information such as the localization and number of lesions and the depth to which they have infiltrated the bowel wall, variables that were evaluated in the present study. Various methods have been used as effective tools for the analysis of bowel lesions, notably transrectal or transvaginal ultrasonography (Chapron *et al.*, 1998; Bazot *et al.*, 2003; Abrao *et al.*, 2004, 2007). In these studies, Abrao and Bazot obtained sensitivity of 100 and 82%, respectively, for the detection of bowel nodules of endometriosis using rectal endoscopic sonography, and 98 and 95%, respectively, with transvaginal ultrasonography.

In the present sample, 63% of all patients had stage III or IV of the disease according to the ASRM classification. However, amongst patients with rectosigmoid endometriosis, 94% (76/81) were in the advanced stages, confirming the strong link between advanced stages of the disease and bowel endometriosis.

The ability of TVUS-BP to detect endometriotic rectosigmoid nodules were similar to Abrao and Bazot previous data, which confirms the efficiency of the method and also shows that transvaginal ultrasound accuracy is comparable to transrectal ultrasound, as shown recently by Piketty *et al.* (2009).

With respect to the multifocality of the disease, 54% of all the patients (105/194) had ovarian endometriosis and 58% (112/194) had retrocervical foci. When only rectosigmoid lesions patients were evaluated, 48% (39/81) and 84% (68/81) had ovarian endometriosis and retrocervical lesions, respectively. These findings are in agreement with other reports highlighting the importance of evaluating all the other possible sites whenever the disease is present in the bowel (Chapron *et al.*, 2003). Furthermore, Chapron *et al.* (2008)

showed that when an ovarian endometrioma is present, the specialist should investigate the extent of the disease to check for severe, multifocal lesions of deep endometriosis.

In the bowel, as in other sites, multiple foci of deep endometriosis have been found in various patients. Chapron *et al.* (2003) found a mean of 1.6 endometriotic nodules per patient in the rectum and/or sigmoid, similar findings to those of the present study (1.5 nodules per patient with intestinal disease). If only the group with multiple lesions is taken into consideration, the mean number of nodules per patient was 2.3, since five patients had three lesions each and in two patients four nodules were found in the rectum and/or sigmoid. Information on the existence of multiple nodules of endometriosis in the bowel is important both when making the decision regarding the need for surgery and in planning the procedure, since this finding may indicate a requirement for segmentary resection rather than removal of the disc, and may lead the surgeon to take greater care in seeking a second or third foci of the disease that may not be evident at first inspection of the pelvis during surgery (Kavallaris *et al.*, 2003).

In the present study, sensitivity of 81%, specificity of 99% and accuracy of 96% were found for the evaluation of presence of at least two rectosigmoid lesions of deep endometriosis in rectum and/or sigmoid. This was a pioneering study to evaluate the accuracy of transvaginal ultrasonography for the detection of multiple foci of endometriosis in the bowel. We realize that this accuracy depends on bowel preparation and on the absence of large fibroids or ovarian cysts situated between the transvaginal transducer and the bowel segment analyzed. Prior bowel preparation allows all the curves and bowel segments to be visualized, which would not be possible if there were gas or fecal residues blocking the ultrasonographic scan. Analysis of bowel multifocality by TVUS-BP is most important when the foci are not in the same bowel segment, due to the need of a greater extension resection of the bowel in these cases, and in view of the risk of the surgeon not visualizing the nodule, principally the proximal nodule. Considering this aspect, TVUS-BP was effective in 94% of patients (30/32), taking into account that in four cases of multifocality the nodules were in the same segment.

With respect to the depth of infiltration of the nodule in the bowel wall, Bazot *et al.* (2003) achieved sensitivity of 100% with transvaginal ultrasonography without prior bowel preparation for the evaluation of lesions that had infiltrated at least as far as the muscularis propria. Using the same method, Menada *et al.* (2008) reported sensitivity of 83%, which increased to 99% when these investigators introduced water into the rectum of patients. More recently, Hudelist *et al.* (2009) also used transvaginal ultrasonography without bowel preparation and reported sensitivity and specificity of 98 and 99%, respectively, for diagnosis of involvement of the muscularis propria and of 62 and 96%, respectively, for evaluation of infiltration of the submucous/mucous layers by deep endometriosis. Using transrectal ultrasonography, Doniec *et al.* (2003) obtained sensitivity of 66% for nodules affecting the submucosal and mucosal layers. Also using transrectal ultrasonography, Roman *et al.* (2008) published findings of a study involving 16 patients and reported sensitivity of 75%; however, specificity was low (58%) due to five false-positive diagnoses of nodules infiltrating the submucosal or mucosal layers. Nevertheless, no study has been published to date showing satisfactory results with transvaginal or transrectal ultrasonography

in evaluating nodules that have infiltrated as far as the submucosal or mucosal layers.

In the present study carried out using TVUS-BP, sensitivity of 100% was obtained for the detection of a lesion affecting at least the muscularis propria. With respect to the submucosal/mucosal layer, sensitivity and specificity were 83 and 94%, respectively, with PPV of 77% and NPV of 96%. In agreement with reports by other authors, there was a greater tendency in the present study to overestimate (9/67) rather than underestimate (6/67) the depth of the lesion. These findings encourage us to consider transvaginal ultrasonography with prior bowel preparation as a pre-operative tool for estimating which bowel layers are affected by deep endometriosis. As this procedure has been used successfully in transrectal ultrasonography, we believe that prior bowel preparation is an essential procedure to ensure satisfactory results in the detection of submucosal involvement. Moreover, our team only presumes that these infiltrations are present when there is a clear and unexpected interruption of the submucosal hyperechoic layer and not just a dislodgment of this layer by the endometriotic nodule.

Adhesions and few millimeters thickness of the bowel external surface may demonstrate correct diagnosis of endometriosis lesions involving serosal layer of the rectosigmoid. This, during the pre-operative work-up, might indicate to the surgeon that it will not be necessary to perform a discoid or segmental resection of the bowel, and provides a warning of accidental lesion of the intestine when performing resection of retrocervical, paracervical or torus uterinus lesions.

Prior bowel preparation minimizes the possibility that a segment of the bowel may not be visualized by the ultrasonographer and also reduces the likelihood of artifacts that may hamper evaluation of the layers of the wall affected by the nodule. In addition, we appreciate that the experience of the examiner, as well as an adequate interaction between the ultrasonographer and the surgeons, is essential for this diagnosis.

These findings suggest that TVUS-BP is an adequate exam for determining the presence of one or more rectosigmoid nodules and the layers of the bowel wall affected by deep endometriosis. This information may be relevant when indicating the surgical procedure to be carried out and in making a decision regarding the type of resection that should be performed (shaving, disc or resection). We believe that the use of TVUS-BP, which is accessible in most institutes, together with the training of more imaging professionals, may improve the diagnosis, therapeutic planning and control of patients with deep bowel endometriosis.

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References

Abrao MS, Neme RM, Averbach M, Petta CA, Aldrighi JM. Rectal endoscopic ultrasound with a radial probe in the assessment of rectovaginal endometriosis. *J Am Assoc Gynecol Laparosc* 2004; **11**:50–54.

- Abrao MS, Goncalves MO, Dias JA Jr, Podgaec S, Chamie LP, Blasbalg R. Comparison between clinical examination, transvaginal sonography and magnetic resonance imaging for the diagnosis of deep endometriosis. *Hum Reprod* 2007; **22**:3092–3097.
- Abrao MS, Podgaec S, Dias JA Jr, Goncalves MO. Diagnosis of rectovaginal endometriosis. *Hum Reprod* 2008a; **23**:2386.
- Abrao MS, Podgaec S, Dias JA Jr, Averbach M, Silva LF, Marino de Carvalho F. Endometriosis lesions that compromise the rectum deeper than the inner muscularis layer have more than 40% of the circumference of the rectum affected by the disease. *J Minim Invasive Gynecol* 2008b; **15**:280–285.
- American Society for Reproductive Medicine (ASRM) classification of endometriosis. 1996. *Fertil Steril* 1997; **67**:817–821.
- Bazot M, Detchev R, Cortez A, Amouyal P, Uzan S, Daraï E. Transvaginal sonography and rectal endoscopic sonography for the assessment of pelvic endometriosis: a preliminary comparison. *Hum Reprod* 2003; **18**:1686–1692.
- Bazot M, Lafont C, Rouzier R, Roseau G, Thomassin-Naggara I, Daraï E. Diagnostic accuracy of physical examination, transvaginal sonography, rectal endoscopic sonography, and magnetic resonance imaging to diagnose deep infiltrating endometriosis. *Fertil Steril* 2009; **92**:1825–1833.
- Biscaldi E, Ferrero S, Fulcheri E, Ragni N, Remorgida V, Rollandi GA. Multislice CT enteroclysis in the diagnosis of bowel endometriosis. *Eur Radiol* 2007; **17**:211–219.
- Chapron C, Dumontier I, Dousset B, Fritel X, Tardif D, Roseau G, Chaussade S, Couturier D, Dubuisson JB. Results and role of rectal endoscopic ultrasonography for patients with deep pelvic endometriosis. *Hum Reprod* 1998; **13**:2266–2270.
- Chapron C, Fauconnier A, Vieira M, Barakat H, Dousset B, Pansini V, Vacher-Lavenu MC, Dubuisson JB. Anatomical distribution of deeply infiltrating endometriosis: surgical implications and proposition for a classification. *Hum Reprod* 2003; **18**:157–161.
- Chapron C, Chopin N, Borghese B, Malartic C, Decuypere F, Foulot H. Surgical management of deeply infiltrating endometriosis: an update. *Ann N Y Acad Sci* 2004; **1034**:326–337.
- Chapron C, Pietin-Vialle C, Borghese B, Davy C, Foulot H, Chopin N. Associated ovarian endometriomas is a marker for greater severity of deeply infiltrating endometriosis. *Fertil Steril* 2009; **92**:453–457.
- Cornillie FJ, Oosterlynck D, Lauweryns JM, Koninckx PR. Deeply infiltrating pelvic endometriosis: histology and clinical significance. *Fertil Steril* 1990; **53**:978–983.
- Daraï E, Thomassin I, Barranger E, Detchev R, Cortez A, Houry S, Bazot M. Feasibility and clinical outcome of laparoscopic colorectal resection for endometriosis. *Am J Obstet Gynecol* 2005; **192**:392–400.
- Doniec JM, Kahlke V, Peetz F, Schniewind B, Mundhenke C, Löhnert MS, Kremer B. Rectal endometriosis: high sensitivity and specificity of endorectal ultrasound with an impact for the operative management. *Dis Colon Rectum* 2003; **46**:1667–1673.
- Dubernard G, Piketty M, Rouzier R, Houry S, Bazot M, Daraï E. Quality of life after laparoscopic colorectal resection for endometriosis. *Hum Reprod* 2006; **21**:1243–1247.
- Duepree HJ, Senagore AJ, Delaney CP, Marcello PW, Brady KM, Falcone T. Laparoscopic resection of deep pelvic endometriosis with rectosigmoid involvement. *J Am Coll Surg* 2002; **195**:754–758.
- Garry R, Clayton R, Hawe J. The effect of endometriosis and its radical laparoscopic excision on quality of life indicators. *BJOG* 2000; **107**:44–54.
- Goncalves MO, Dias JA Jr, Podgaec S, Averbach M, Abrao MS. Transvaginal ultrasound for diagnosis of deeply infiltrating endometriosis. *Int J Gynaecol Obstet* 2009; **104**:156–160.
- Guerriero S, Ajossa S, Gerada M, Virgilio B, Angioni S, Melis GB. Diagnostic value of transvaginal 'tenderness-guided' ultrasonography

- for the prediction of location of deep endometriosis. *Hum Reprod* 2008; **23**:2452–2457.
- Hudelist G, Tuttlies F, Rauter G, Pucher S, Keckstein J. Can transvaginal sonography predict infiltration depth in patients with deep infiltrating endometriosis of the rectum? *Hum Reprod* 2009; **24**:1012–1017.
- Kavallaris A, Köhler C, Kühne-Heidd R, Schneider A. Histopathological extent of rectal invasion by rectovaginal endometriosis. *Hum Reprod* 2003; **18**:1323–1327.
- Koga K, Osuga Y, Yano T, Momoeda M, Yoshino O, Hirota Y, Kugu K, Nishii O, Tsutsumi O, Taketani Y. Characteristic images of deeply infiltrating rectosigmoid endometriosis on transvaginal and transrectal ultrasonography. *Hum Reprod* 2003; **18**:1328–1333.
- Menada MV, Remorgida V, Abbamonte LH, Fulcheri E, Ragni N, Ferrero S. Transvaginal ultrasonography combined with water-contrast in the rectum in the diagnosis of rectovaginal endometriosis infiltrating the bowel. *Fertil Steril* 2008; **89**:699–700.
- Piketty M, Chopin N, Dousset B, Millischer-Bellaische A, Roseau G, Leconte M, Borghese B, Chapron C. Pre-operative work-up for patients with deeply endometriosis: transvaginal ultrasonography must definitely be the first-line imaging examination. *Hum Reprod* 2009; **24**:602–607.
- Remorgida V, Ragni N, Ferrero S, Anserini P, Torelli P, Fulcheri E. How complete is full thickness disc resection of bowel endometriotic lesions? A prospective surgical and histological study. *Hum Reprod* 2005; **20**:2317–2320.
- Remorgida V, Ferrero S, Fulcheri E, Ragni N, Martin DC. Bowel endometriosis: presentation, diagnosis, and treatment. *Obstet Gynecol Surv* 2007; **62**:461–470.
- Ribeiro HS, Ribeiro PA, Rossini L, Rodrigues FC, Donadio N, Aoki T. Double-contrast barium enema and transrectal endoscopic ultrasonography in the diagnosis of intestinal deeply infiltrating endometriosis. *J Minim Invasive Gynecol* 2008; **15**:315–320.
- Roman H, Kouteich K, Gromez A, Hochain P, Resch B, Marpeau L. Endorectal ultrasound accuracy in the diagnosis of rectal endometriosis infiltration depth. *Fertil Steril* 2008; **90**:1008–1013.
- Vignali M, Bianchi S, Candiani M, Spadaccini G, Oggioni G, Busacca M. Surgical treatment of deep endometriosis and risk of recurrence. *J Minim Invasive Gynecol* 2005; **12**:508–513.

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