Ultrasound Obstet Gynecol 2012; **40**: 464–469
Published online 17 September 2012 in Wiley Online Library (wileyonlinelibrary.com). **DOI:** 10.1002/uog.11102

Comparison between transvaginal sonography, saline contrast sonovaginography and magnetic resonance imaging in the diagnosis of posterior deep infiltrating endometriosis

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KEYWORDS: deep pelvic endometriosis; laparoscopy; magnetic resonance imaging; sonovaginography; ultrasound

ABSTRACT

Objective *To compare clinical evaluation, transvaginal sonography (TVS), saline contrast sonovaginography (SCSV) and magnetic resonance imaging (MRI) in the diagnosis of posterior deep pelvic endometriosis (DPE).*

Methods *Women suspected of having posterior DPE on the basis of subjective symptoms and clinical evaluation underwent digital vaginal and rectal examination, TVS, SCSV and MRI. Laparoscopy was performed and specimens were sent for histological examination. Sensitivity, specificity, positive and negative predictive value, as well as positive and negative likelihood ratios were analyzed for each diagnostic method.*

Results *Fifty-four out of 102 women suspected of having posterior DPE underwent laparoscopic surgery. Among these, in 46 (85.2%) cases DPE was confirmed at laparoscopic and histological examination. SCSV correctly identified 43 (93.5%) cases, presenting higher accuracy than did the other procedures. SCSV and MRI were more accurate in diagnosing and discriminating between the different locations of endometriotic lesions, with respective sensitivities of 94.7 and 73.1% for vaginal fornix, 88.9 and 66.7% for the uterosacral ligaments and 80.6 and 83.3% for involvement of the rectovaginal septum. The specificity of SCSV and MRI, respectively, was 97.1 and 94.3% for vaginal fornix, 95.6 and 95.6% for uterosacral ligaments and 100 and 77.8% for involvement of the rectovaginal septum. In the diagnosis of rectal endometriosis, we found a sensitivity of 66.7% for both techniques and specificity of 93.8% for SCSV and 95.8% for MRI.*

Conclusion *TVS should be used as the first-line diagnostic technique and SCSV and/or MRI as second-line methods in the diagnosis of posterior DPE. Copyright © 2012 ISUOG. Published by John Wiley & Sons, Ltd.*

INTRODUCTION

Deep pelvic endometriosis (DPE) is defined as the presence of endometrial implants, fibrosis and muscular hyperplasia penetrating more than 5 mm into the peritoneum[1]. It occurs in 15–30% of patients with endometriosis[2] and may involve the uterosacral ligaments, the pouch of Douglas, the rectosigmoid colon, the rectovaginal space, the vagina and, occasionally, the bladder[3]. Endometriosis may cause dysmenorrhea, chronic pelvic pain, deep dyspareunia and infertility, and when it infiltrates the rectal or sigmoid wall it may also cause dyschezia and hematochezia. These symptoms can compromise the patient's quality of life enough to justify invasive surgery[4]. Radical laparoscopic removal of all endometriotic lesions is considered the best management, and, in case of deep endometriosis infiltrating the vaginal or rectal wall, specific procedures are required[5,6] that present a real risk of complications[7] and need collaboration with gastrointestinal tract surgeons. Non-invasive methods are therefore required to obtain a preoperative diagnosis of the location and extent of endometriotic lesions and of the existence of intestinal infiltration, in order to inform the patient about the various treatment possibilities with their respective risks, and to obtain an adequate basis on which to decide the surgery strategy.

Clinical examination and the patient's medical history of preoperative symptoms are limited in establishing the extent of DPE lesions, as it is not possible to determine the precise relationship between a specific symptom and the anatomic–surgical characteristics of endometriotic lesions[8–10]. Transvaginal sonography (TVS) has been advocated by some as the first-line imaging technique because it allows extensive exploration of the pelvis, it is well accepted and widely available[11–14], while others support magnetic resonance imaging (MRI) because of

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Accepted: 4 January 2012

its accuracy[15–21]. Another new technique considered for the diagnosis of DPE is saline contrast sonovaginography (SCSV). First described by Dessole *et al.*[22], it consists of TVS combined with the introduction of saline solution into the vagina, which allows more complete visualization of the vaginal walls and fornix, pouch of Douglas, uterosacral ligaments and rectovaginal septum.

The aim of this study was to analyze the characteristics of the techniques commonly used in the diagnosis of posterior DPE and, particularly, to compare SCSV with MRI.

PATIENTS AND METHODS

In this prospective study we enrolled 102 symptomatic women referred to the Endometriosis and Chronic Pelvic Pain Office of the Department of Gynaecological Science and Human Reproduction of Padua during the period from February 2005 to October 2010, suspected of having posterior DPE on the basis of subjective symptoms and clinical evaluation. Each patient underwent digital vaginal and rectal examination, TVS, MRI and SCSV. Among the 102 women, 54 patients underwent laparoscopic surgery to remove all endometriotic lesions on the basis of their severe symptoms and acceptance of the risk of rectal and/or vaginal resection.

Inclusion criteria were: presence of at least one symptom (from moderate to severe) correlated with DPE (chronic pelvic pain, dysmenorrhea, deep dyspareunia and dyschezia), and presence of one or more lesions identified as DPE at clinical or imaging evaluation (TVS, SCSV or MRI). Exclusion criteria were: contraindications for MRI and laparoscopic surgery and refusal of the patient to provide informed consent.

For each patient we collected age at surgery, parity, body mass index (BMI) and hormonal treatment before surgery. All women were asked to describe their pain during the two ultrasound imaging procedures using a 10-point visual analog scale (VAS).

The first clinical investigations were digital vaginal and rectal examinations, which were considered suggestive of DPE when an area of thickening or a nodule in the uterosacral ligaments or in the vaginal cul-de-sac, or a painful nodule in the rectovaginal septum was found.

The first-line imaging method used was TVS. All examinations were performed by the same operator (E.C.) using a 6.5-MHz transvaginal probe (Siemens Sonoline-1, Erlangen, Germany) in the secretory phase of the menstrual cycle and they included routine analysis of the uterus and ovaries and analysis of the peritoneal surface that covers the pouch of Douglas, the retrocervical area (uterosacral ligaments, torus uterinus and posterior vaginal fornix) and the rectovaginal septum. We suspected deep retrocervical endometriosis when a thick block of hypoechoic tissue, nodular or irregular formations or retractable masses were found in this area, including lesions on the uterosacral ligament, pouch of Douglas and/or vagina. We also searched for free fluid, obliteration of the pouch of Douglas and signs of adhesion to adjacent structures, assessing the simultaneous changes of the position of adjacent structures during the Valsalva maneuver, movement of the probe and pressure on the abdomen by the operator.

As a second stage, a team of two operators (E.C. and C. S., as the methodology requires the presence of two operators) performed SCSV in the same session. The procedure consisted of TVS combined with the introduction of saline solution into the vagina. A 6.5-MHz transvaginal probe was used (Siemens Sonoline-1) with, at its base, a purpose-designed hydraulic ring (Colpo-Pneumo Occluder, Cooper Surgical, Berlin, Germany) that inflates with approximately 40 mL of saline solution in order to prevent the escape of the 60–120 mL of saline that is subsequently injected into the vagina using a Foley catheter. The solution creates an acoustic window between the transvaginal probe and the surrounding structures of the vagina and exerts a pressure that distends the vaginal walls, permitting more complete visualization of the vaginal walls and fornix, uterosacral ligaments, pouch of Douglas and rectovaginal septum[22].

Endometriotic lesions were detected as irregular hypoechoic structures at the level of the vaginal wall, often infiltrating the surrounding structures and uterosacral ligaments. Once an endometriotic lesion had been detected, we recorded the location and degree of infiltration[22]. Exophytic lesions or plaque protruding from the posterior vaginal fornix was classified as vaginal fornix DPE. Lesions deeply infiltrating the rectovaginal septum were considered as rectovaginal DPE, and when they infiltrated the rectal wall, fixing the rectal tract during Valsalva maneuver or pressure with the probe, they were interpreted as rectal endometriosis. Lateral lesions infiltrating the uterosacral ligaments were considered to be uterosacral DPE (Figures 1–3). TVS and SCSV were performed without bowel preparation (i.e. without use of laxatives or enema), and with the operators blinded to the results of the other investigations.

All patients also underwent MRI using a 1-T MR imaging system (Siemens Harmony, Erlangen, Germany) by a single expert radiologist (A.T.) previously

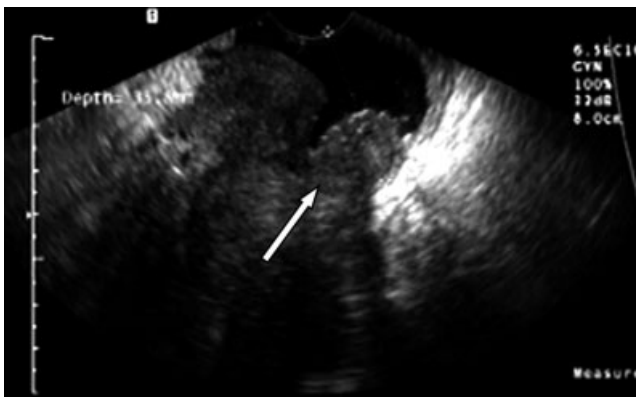

Figure 1 Saline contrast sonovaginographic image showing exophytic endometriotic lesion (arrow) at level of posterior vaginal fornix.

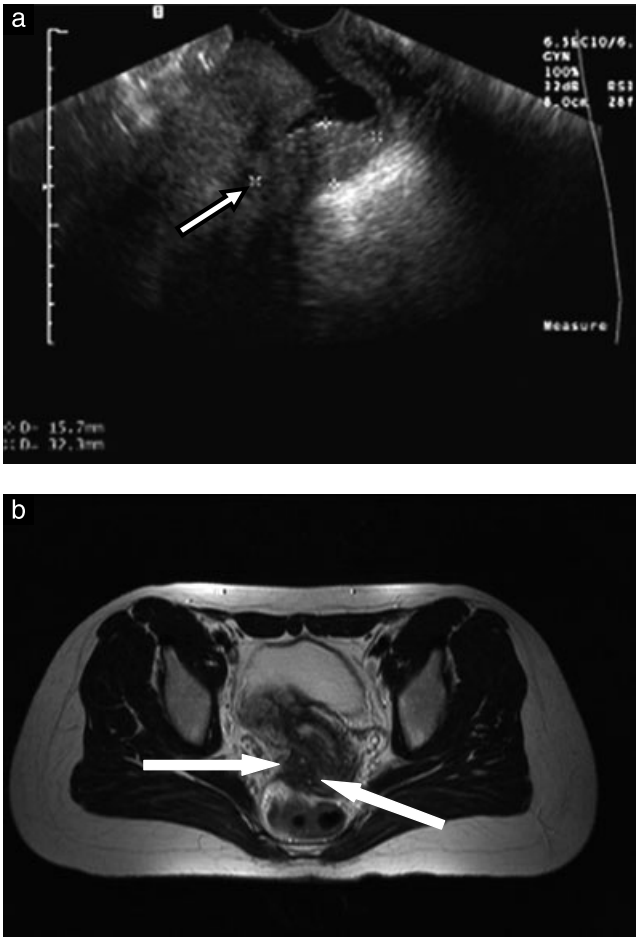

Figure 2 Saline contrast sonovaginographic image (a) and T2-weighted axial turbo spin echo magnetic resonance image (b) showing endometriotic nodule in the rectovaginal space (arrows) involving the posterior vaginal fornix, with thickening of the rectal fascia and eccentric distension of the vagina.

informed about the patient's history, but not about the results of the other imaging examinations. Before the examination we administered 20 mg of hyoscine butylbromide (Buscopan) to reduce intestinal peristalsis. Patients did not undergo any bowel preparation. We used routine clinical sequences: 5-mm thickness T2 turbo spin echo weighted images in axial, sagittal and coronal planes were acquired. Axial T1 images with and without fat suppression were also collected, before and after intravenous injection of gadolinium contrast medium (0.1 mL/kg of body weight of gadopentetate dimeglumine). The protocol also included administration of vaginal sterile ultrasound gel.

The diagnosis of DPE was based on the combined presence of morphological abnormalities and signal abnormalities such as hyperintense foci on T1-weighted and/or fat-suppression T1-weighted MR images, corresponding to hemorrhagic foci or small hyperintense cavities on T2-weighted images, or areas corresponding to fibrosis, with a signal close to that of pelvic muscle on T1- and T2-weighted images, with or without foci or cavities and with or without contrast enhancement after injection of contrast medium (Figures 2 and 3).

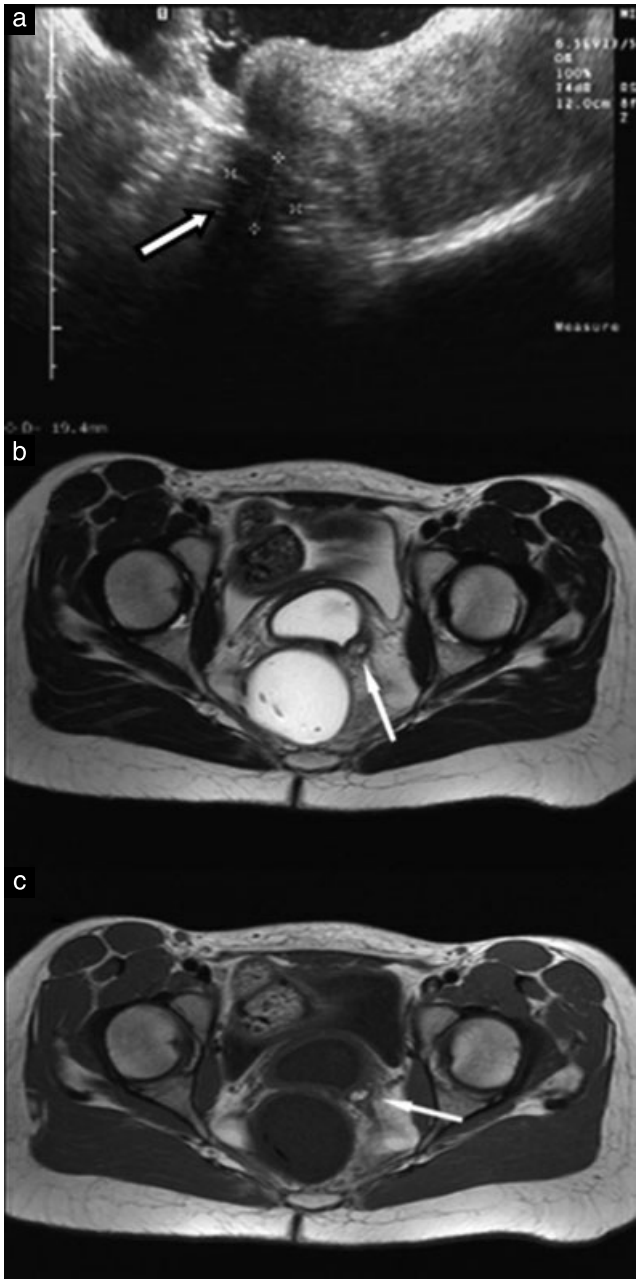

Figure 3 (a) Saline contrast sonovaginographic image showing hypoechoic endometriotic nodule (arrow) in rectovaginal septum without infiltration of vaginal or rectal wall; (b) axial magnetic resonance T2-weighted image of the nodule shows small hyperintense central area that remains hyperintense on T1-weighted imaging (c) owing to a hemorrhagic or protein component (arrow).

All 54 women finally underwent laparoscopic surgery to remove all the endometriotic tissue and specimens were sent for histological examination.

Statistical analysis

For each diagnostic method we calculated sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV), as well as positive and negative likelihood ratios. Data regarding VAS pain score of TVS and SCSV were compared using Student's *t*-test. $P < 0.05$ was considered statistically significant.

RESULTS

The mean age of the 54 women was 32.3 ± 5.8 years and mean BMI was 20.6 ± 2.2 kg/m^2. Forty-seven (87.0%) of the women were nulliparous. In 28 (51.9%) cases the patients were receiving hormonal treatment before surgery, in 22 (40.7%) cases estroprogestins were being taken for contraception and/or endometriosis, and in six (11.1%) cases gonadotropin-releasing hormone analog treatment had been administered for 3–6 months. No patient underwent hormonal treatment after surgery.

In 20 (37.0%) cases a vaginal excision and in six (11.1%) cases a segmental bowel resection was performed. In 46 (85.2%) cases DPE was confirmed at laparoscopic investigation and histological examination, and in the other eight (14.8%) cases pelvic adhesions, obliteration of the pouch of Douglas and/or superficial pelvic endometriosis were found. Among the patients with DPE, 36 (78.3%) cases showed rectovaginal septum involvement, 19 (41.3%) showed vaginal fornix involvement and in nine (19.6%) cases the uterosacral ligaments were involved (some cases having more than one site affected).

In the diagnosis of the presence of endometriotic lesions, clinical examination identified 40 out of 46 (87.0%) cases, TVS identified 34 (73.9%), SCSV identified 43 (93.5%) and MRI identified 42 (91.3%). Diagnostic performance data of these three techniques are given in Table 1, and data for diagnosis in the three specific locations (vaginal fornix, uterosacral ligaments and rectovaginal septum) are shown in Table 2. Table 3 gives performance data of TVS, SCSV and MRI in the diagnosis of rectal endometriosis.

The mean VAS pain score for TVS was 2.6 ± 1.7 and for SCSV it was 2.1 ± 1.8, a difference that was not significant ($P = 0.141$).

DISCUSSION

As the surgical treatment of posterior DPE may be challenging for surgeons and carry significant risks for patients, preoperative assessment of the location, characteristics and presence or absence of vaginal or rectal wall infiltration by endometriotic lesions is important in order to inform the patient about the various treatment possibilities, with their respective risks, and to allow adequate counseling regarding treatment strategy.

TVS is commonly adopted as the first-line imaging procedure in women with suspected DPE because it permits an extensive exploration of the pelvis, can detect, for example, rectal wall infiltration, and is well accepted, widely available and not expensive[14]. Bazot *et al.*[11] in a study in 2003, using TVS for the diagnosis of intestinal DPE, achieved a sensitivity and specificity of 95% and 100%. Abrao *et al.* in 2007[10] obtained a sensitivity and specificity of 98.1% and 100% and Hudelist *et al.*[13] in 2009 also presented high values, with a sensitivity of 96% and specificity of 98%. Another study, published in

Table 1 Performance of clinical examination, transvaginal sonography (TVS), saline contrast sonovaginography (SCSV) and magnetic resonance imaging (MRI) in the detection of posterior deep pelvic endometriosis

Parameter	*Clinical examination*	*TVS*	*SCSV*	*MRI*
Sensitivity (%)	87.0	73.9	93.5	91.3
Specificity (%)	75.0	87.5	87.5	75.0
PPV (%)	95.2	97.1	97.7	95.5
NPV (%)	50.0	36.8	70.0	60.0
LR+	3.48	5.91	7.47	3.65
LR−	0.17	0.29	0.07	0.11

LR+, positive likelihood ratio; LR−, negative likelihood ratio; NPV, negative predictive value; PPV, positive predictive value.

Table 2 Performance of clinical examination, transvaginal sonography (TVS), saline contrast sonovaginography (SCSV) and magnetic resonance imaging (MRI) in discrimination of location of deep posterior endometriotic nodules

Parameter	*Clinical examination*	*TVS*	*SCSV*	*MRI*
Vaginal fornix				
Sensitivity (%)	57.9	57.9	94.7	73.1
Specificity (%)	88.6	91.4	97.1	94.3
PPV (%)	73.3	78.6	94.7	87.5
NPV (%)	79.5	80.0	97.1	86.8
LR+	5.065	6.75	33.157	12.89
LR−	0.475	0.46	0.054	0.279
Uterosacral ligaments				
Sensitivity (%)	55.6	55.6	88.9	66.7
Specificity (%)	80.0	95.6	95.6	95.6
PPV (%)	35.7	71.4	80.0	75.0
NPV (%)	90.0	91.5	97.7	93.5
LR+	2.77	12.5	19.99	14.99
LR−	0.55	0.465	0.11	0.34
RVS involvement				
Sensitivity (%)	58.3	63.9	80.6	83.3
Specificity (%)	83.3	88.9	100	77.8
PPV (%)	87.5	92.0	100	88.2
NPV (%)	50.0	55.2	72.0	70.0
LR+	1.75	5.75	∞	5.95
LR−	0.25	0.41	0.194	0.34

LR+, positive likelihood ratio; LR−, negative likelihood ratio; NPV, negative predictive value; PPV, positive predictive value; RVS, rectovaginal septum.

Table 3 Performance of transvaginal sonography (TVS), saline contrast sonovaginography (SCSV) and magnetic resonance imaging (MRI) in evaluation of bowel infiltration by deep endometriotic nodules

Parameter	*TVS*	*SCSV*	*MRI*
Sensitivity (%)	33.3	66.7	66.7
Specificity (%)	91.7	93.8	95.8
PPV (%)	33.3	57.1	66.7
NPV (%)	91.7	95.7	95.8
LR+	4.0	10.66	16.0
LR−	0.727	0.355	0.347

LR+, positive likelihood ratio; LR−, negative likelihood ratio; NPV, negative predictive value; PPV, positive predictive value.

2010 by Goncalves *et al.*[23], showed that TVS with bowel preparation can diagnose endometriosis of the rectum and sigmoid with high sensitivity (97%) and specificity (100%). Other authors have achieved lower levels of diagnostic accuracy with TVS, leading them to propose new ultrasound methods to increase the detection rate of DPE[22,24–26]. We argue that it is probable that the operators who achieved excellent results with TVS were highly experienced and ultraspecialized in the diagnosis of DPE, while other operators, although experienced, could not achieve such high detection rates. In our study TVS, although performed by an experienced operator, achieved a good specificity (87.5%) but lower sensitivity (73.9%), with NPV 36.8%, LR+ 5.91 and LR− 0.29.

Menada *et al.*[24] tested TVS combined with water-contrast in the rectum (RWC-TVS) in patients with suspected rectovaginal endometriosis; this technique presented higher accuracy than simple TVS in the diagnosis of rectal endometriosis (sensitivity 97%, specificity 100%, PPV 100% and NPV 91.3%) but lower specificity in the diagnosis of endometriotic lesions located in the uterosacral ligaments, retrocervical area and pouch of Douglas. Bergamini *et al.*[25] also tested RWC-TVS, reporting that it has the same accuracy as transrectal sonography and effectiveness equal to that of barium enema in the detection of a significant intestinal lumen stenosis related to rectosigmoid endometriosis.

In 2003 Dessole *et al.*[22] presented a new ultrasonographic technique, SCSV, as a more accurate and specific examination than TVS in the diagnosis of DPE, achieving a sensitivity of 90.6%, specificity 85.7%, PPV 93.5% and NPV 80%. SCSV is simple, with low pain or discomfort for the patient and it can be performed directly by the gynecologist at limited expense[27]. It provides information on the location, extent and infiltration of endometriotic lesions in the rectovaginal septum. It can also be performed as a dynamic test because the operator can assess changes in the position of endometriotic nodules compared to the rectal wall position and assess the suspicion of bowel infiltration. However, a limitation of this technique is that it depends on the examiner's ability and experience.

In our study, we opted for comparison of the two ultrasonographic techniques with MRI, as it is an efficient and widely used technique, highly accurate for the diagnosis of posterior DPE[15–21]. It allows evaluation in multiple planes of multifocal, scattered and small endometriotic lesions and it also allows a relatively objective assessment, although there is a learning curve that depends on the specific anatomic location of the endometriosis[28]. Additionally, analysis of the images obtained can be performed subsequently and independently by several observers. Nevertheless MRI cannot accurately estimate the depth of penetration of endometriosis in the muscolaris propria of the intestinal wall, it can be limited by artifacts related to the presence of fecal residuals, enhanced intestinal peristalsis or anatomical anomalies of the patient and it is more expensive than other methods.

In our experience, SCSV achieved better results than did the other techniques reviewed here and it was also scored as being more comfortable for the patient than TVS, although the difference was not statistically significant. We also observed that MRI and even more so SCSV are more accurate in diagnosing and discriminating between the different locations of endometriotic lesions.

In the diagnosis of rectal endometriosis, we found a sensitivity of only 66.7% for both SCSV and MRI, but good values of specificity of 93.8% and 95.8%, respectively, showing that both techniques may help in the diagnosis and precise location of DPE and of rectal endometriotic infiltration. SCSV could therefore be an option for those operators who do not achieve good results with TVS.

Guerriero *et al.*[26,29] tested another variant of contrast-enhanced TVS, 'tenderness-guided' transvaginal sonography (tg-TVS); a dynamic technique that involves creating an acoustic window between the probe and the surrounding vaginal structures by increased amounts of ultrasound gel inside the probe cover and asking the patient to indicate which points are more painful under gentle pressure from the probe during the examination. Using this new approach, the authors achieved a specificity of 95%, sensitivity of 90%, PPV of 97% and NPV of 86% in detecting DPE. Recently Saba *et al.*[30] compared tg-TVS with MRI, stating that the two methods present similar results in the identification of rectosigmoid endometriosis. When used in combination the sensitivity increased to 95%, suggesting that tg-TVS and MRI have complementary roles in the diagnosis of rectosigmoid endometriosis, depending on the site affected[30].

In our opinion, physical examination together with TVS could be adopted as first-line diagnostic techniques, in accordance with Hudelist *et al.*[31], who showed that their combination accurately predicts endometriosis. Both SCSV and MRI could be used as second-line methods to help in the diagnosis of DPE in symptomatic women. SCSV is simple, well tolerated and less expensive than MRI and it is also a dynamic test that can be performed directly by the gynecologist, while MRI has the advantage of objectivity in the procedure and analysis.

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