Ultrasound Obstet Gynecol 2010; **36**: 241–248
Published online in Wiley InterScience (www.interscience.wiley.com). **DOI:** 10.1002/uog.7689

Value of transvaginal ultrasound in assessing severity of pelvic endometriosis

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KEYWORDS: diagnosis; endometriosis; laparoscopy; severity; transvaginal ultrasound

ABSTRACT

Objective *The objective of this study was to examine the ability of preoperative transvaginal ultrasound (TVS) scanning to assess the severity of pelvic endometriosis.*

Methods *Consecutive women with clinically suspected or proven pelvic endometriosis, who were booked for laparoscopy, were invited to join the study. The severity of endometriosis was assessed preoperatively using TVS and the findings were compared with the results obtained by laparoscopy using the American Society for Reproductive Medicine (ASRM) classification.*

Results *In total, 201 women had preoperative TVS and laparoscopies. Of these, no endometriosis was found at laparoscopy for 62/201 (30.8%; 95% CI, 24.8–37.5), whereas 33/201 (16.4%; 95% CI, 11.9–22.2) had minimal endometriosis, 31/201 (15.4%; 95% CI, 11.1–21.1) had mild endometriosis, 27/201 (13.4%; 95% CI, 9.4–18.8) had moderate endometriosis and 48/201 (23.9%; 95% CI, 18.5–30.2) had severe endometriosis. The sensitivity and specificity of the TVS diagnosis of severe pelvic endometriosis were 0.85 (95% CI, 0.716–0.934) and 0.98 (95% CI, 0.939–0.994), respectively, and the positive and negative likelihood ratios were 43.5 (95% CI, 14.1–134) and 0.15 (95% CI, 0.075–0.295), respectively. Overall, there was a good level of agreement between ultrasound and laparoscopy in identifying absent, minimal, mild, moderate and severe disease (quadratic weighted kappa = 0.786). The mean ASRM score difference between TVS and laparoscopy in assessing severity of endometriosis was −2.398 (95% CI, −4.685 to −0.1112) and the limits of agreement were −34.62 (95% CI, −38.54 to −30.709) to 29.83 (95% CI, 25.91–33.74).*

Conclusions *TVS is a good test for assessing the severity of pelvic endometriosis. TVS is particularly accurate in detecting severe disease, which could facilitate more effective triaging of women for appropriate surgical care.*

INTRODUCTION

Endometriosis is a common gynecological condition, defined as the presence of endometrial-like tissue outside the uterus, which impairs quality of life[1]. In more severe cases it forms cysts in the ovaries and deeply infiltrates pelvic organs.

The revised American Society for Reproductive Medicine (ASRM) classification is the most widely accepted staging system for endometriosis; however, there is no consensus regarding the definition of severe endometriosis.

In the last few decades, a non-invasive preoperative diagnosis of endometriosis has been made possible by advances in imaging methods such as ultrasound and magnetic resonance imaging (MRI)[2,3]. The value of ultrasound for the diagnosis of ovarian endometriomas has been established[4]. Rectal endoscopic sonography (RES), transrectal sonography (TRS) and transvaginal ultrasound (TVS) have all been shown to be useful in the diagnosis of non-ovarian features of endometriosis, such as intestinal, bladder and uterosacral ligament involvement[5–7]. A recent study showed the high degree of accuracy of good-quality TVS when combined with a bimanual examination for the diagnosis of deep pelvic endometriosis[8]. In addition, three other studies showed that TVS is comparable with, and may be superior to, MRI[3,9,10].

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Accepted: 20 April 2010

The success of surgery for pelvic endometriosis is highly dependent on the expertise and training of the operating surgeon[11,12]. In an attempt to optimize the treatment of women suffering from severe endometriosis, tertiary referral endometriosis centers have been established[11]. These centers provide comprehensive care for endometriosis patients, including high-quality surgical care. The capacity of tertiary centers, however, is limited and the critical issue in routine clinical practice is the ability to assess the severity of endometriosis in order to facilitate the triaging of women for treatment.

The aim of the present study was to establish whether preoperative ultrasound examination is an accurate method for diagnosing severe pelvic endometriosis.

METHODS

This was a prospective, observational, multicenter study, which was conducted at King's College Hospital and at University College Hospital in London. These are major teaching hospitals and the latter includes a specialist tertiary endometriosis center. Consecutive women with clinically suspected or proven pelvic endometriosis were invited to join the study. The inclusion criteria were: premenopausal women with a clinical suspicion of endometriosis awaiting diagnostic laparoscopy; women diagnosed with pelvic endometriosis at diagnostic laparoscopy awaiting operative treatment; age ≥ 16 years; and the ability to provide informed consent. Exclusion criteria were: women who could not undergo a TVS scan; and women who became pregnant whilst awaiting surgery.

The study was approved by the local ethics committee, and an information leaflet was given to all eligible women before assessment. Informed consent was obtained from all patients who agreed to take part in the study.

Procedures

All women were assessed by the attending clinicians who obtained a detailed medical history, which was recorded on a dedicated clinical database (ViewPoint; GE Healthcare, Fairfield, CT, USA). Women were specifically asked about symptoms associated with endometriosis such as dysmenorrhea, chronic pelvic pain, dyspareunia, subfertility, dyschezia and cyclic rectal bleeding.

TVS examination was performed by four ultrasound operators who were all gynecologists with a high level of expertise in gynecological ultrasonography. The ultrasound operators were blinded to any previous surgical findings. All patients were operated on by four different laparoscopic surgeons with a high level of expertise in laparoscopic surgery. When moderate, severe or deeply invasive endometriosis (DIE) was present, a complete surgical exploration of the pelvis was performed, involving dissection of the pouch of Douglas when obliterated and resection of any DIE, especially of the bowel or the rectovaginal septum (RVS), in order not to miss any disease. The operating surgeons were blinded to the detailed TVS findings.

TVS assessment of pelvic endometriosis

All women were examined in the dorsal lithotomy position using a high-resolution TVS probe. The examinations were performed in a standardized and systematic way. First of all, the uterus was assessed in the transverse and sagittal planes. Then, the ovaries were found and their size was measured in three orthogonal planes.

Ovarian cysts were diagnosed as endometriomas when they appeared as well-circumscribed thick-walled cysts that contained homogeneous low-level internal echoes ('ground glass')[13]. Measurements were recorded from the inside of the cyst wall in three orthogonal planes. The average of the three diameters (D1+D2+D3)/3 was used for scoring. The adnexa were also systematically examined for the presence of tubal dilatation. When tubal dilatation was present, a score of 16 was given, in accordance with the ASRM system.

Ovarian mobility was assessed by a combination of gentle pressure with the vaginal probe and abdominal pressure with the examiner's free hand, as in a bimanual examination. The ovary was deemed to be completely free when it could be seen sliding across the surrounding structures without any resistance. Minimal adhesions (classified in the ASRM classification as $< 1/3$ enclosure with dense adhesions) were considered to be present when some of the surrounding structures could not be separated from the ovary with gentle pressure but the ovary could be mobilized from the majority ($> 2/3$) of the surrounding structures. Moderate adhesions (classified in the ASRM classification as $1/3$ to $2/3$ enclosure with dense adhesions) were thought to be present when the ovarian mobility was reduced as a result of adhesions with the surrounding structures but the structures on $2/3$ to $1/3$ of the surface of the ovary slid across it with the application of gentle pressure. Fixed ovaries (assessed in the ASRM classification as $> 2/3$ enclosure with dense adhesions) could not be mobilized at all with gentle pressure or separated from the surrounding structures. If the tubes were dilated, the mobility of the dilated tubes was documented in a similar manner. Normal Fallopian tubes are difficult to identify in the absence of background fluid in the pelvis and therefore it was not possible to score non-dilated tubes for adhesions. Filmy adhesions were scored separately from dense adhesions of the tubes and ovaries in the ASRM system. It is difficult to see filmy adhesions on TVS unless there is fluid entrapped within the adhesions, giving rise to the 'flapping sail sign', or unless the mobility of the affected organs is reduced, and therefore these features were not scored separately at TVS examination.

Next, the presence of adhesions in the pouch of Douglas was assessed. The uterus was gently mobilized by a combination of pressure on the cervix with the ultrasound probe alternating with pressure on the fundus from the examiner's free hand on the abdominal wall. The aim was

to watch the interface of the posterior uterine serosa and the bowel behind to ensure that the two structures were sliding easily across one another. If these two surfaces were completely free of one another, this was assessed as no adhesions present. Complete obliteration was assessed as the absence of any sliding between the serosa on the posterior surface of the cervix or uterus and the bowel behind. Partial obliteration of the pouch of Douglas was present if there were some adhesions between the bowel and the uterus, but some free sliding was seen. Partial obliteration was also present when adnexal structures were firmly adherent to the posterior aspect of the uterus but the bowel appeared to be free.

Endometriotic nodules or DIE were typically visualized as stellate hypoechoic or isoechogenic solid masses with irregular outer margins[14,15], which were tender on palpation and fixed to the surrounding pelvic structures. They were usually located in the uterosacral ligaments, adnexa, rectovaginal septum and urinary bladder. Endometriotic nodules located in the wall of the rectosigmoid colon tend to appear as hypoechoic thickenings of bowel muscularis propria, which sometimes protrude into the lumen of the bowel[16]. The presence and largest diameter of any deep lesions were documented.

The above features were documented and scored using the ASRM classification[17]. The score was used to grade the disease as absent (0), minimal (1–5), mild (6–15), moderate (16–40) or severe (> 40). DIE is given a maximum score of six on the ASRM classification and therefore we recorded the presence of these lesions separately. All findings were recorded on a database file using a Microsoft Excel for Windows spreadsheet to facilitate data entry and retrieval. The severity of endometriosis, as assessed by TVS, was compared with laparoscopic findings using the same ASRM classification.

Statistical analysis

As no previous studies have been conducted to assess the accuracy of ultrasound scanning, carried out by experts, to determine the severity of endometriosis, there are no figures on which to base a power calculation. In clinical practice it would be ideal to identify all cases of endometriosis. Our hypothesis was that it would be clinically acceptable if TVS had a sensitivity of 90% in identifying severe pelvic endometriosis. This study was designed to have 90% power to detect a 10% difference between the sensitivity of diagnostic laparoscopy and TVS in detecting severe pelvic endometriosis with a two-sided alpha of 0.05. The study needed a minimum of 190 patients, but we recruited 211 patients to allow for loss of power as a result of cancellations or pregnancy.

All statistical analyses were carried out using MEDCALC version 9.2.0.2 (Medcalc Software, Mariakerke, Belgium). The diagnostic accuracy of the tests was assessed using sensitivity, specificity, positive likelihood ratio (LR+) and negative likelihood ratio (LR−) measurements. Correlation was calculated using the coefficient of correlation *r*. In order to determine any systematic bias between the two diagnostic methods and to assess the relationship between any differences and the magnitude of the scores, the differences in score were plotted against the mean of the two scores on a scatter diagram. Systematic bias between the two observers was determined by calculating the 95% CI of the mean (mean ± 1.96 SD), as described by Bland and Altman[18,19]. Overall levels of agreement were calculated using Cohen's quadratic weighted kappa coefficient. Kappa values of 0.81–1.0 indicated very good agreement, kappa values of 0.61–0.80 indicated good agreement, kappa values of 0.41–0.60 indicated moderate agreement, kappa values of 0.21–0.40 indicated fair agreement and kappa values of < 0.20 indicated poor agreement[20].

RESULTS

In the 30-month period from July 2006 to December 2008 we recruited 211 women into this study. Ten women were excluded from the final analysis: five became pregnant whilst awaiting surgery, one cancelled her operation, one laparoscopy was unsuccessful and three women were lost to follow-up.

In total, 201 women were included in the final analysis. The mean age was 34.9 (95% CI, 33.98–35.86; SD, 6.79) (range, 19–51) years. The presenting symptoms were: dysmenorrhea (142/201, 70.6%), chronic pelvic pain (104/201, 51.7%), dyspareunia (78/201, 38.8%), infertility (38/201, 18.9%), dyschezia (7/201, 3.5%) and cyclic rectal bleeding (2/201, 1%) women. A single presenting symptom was present in 72 (35.6%) women, two presenting symptoms in 78 (38.8%) women and three or more symptoms in 51 (25.4%) women.

The ultrasound examinations were performed by four examiners: Examiner A performed 104 (51.7%), Examiner B performed 68 (33.8%), Examiner C performed 18 (9%) and Examiner D performed 11 (5.5%) examinations. All patients were operated on by one of four laparoscopic surgeons: Surgeon A operated on 70 (34.8%), Surgeon B operated on 52 (25.9%), Surgeon C operated on 45 (22.3%) and Surgeon D operated on 34 (16.9%) women. The mean interval between TVS and surgery was 37.5 (95% CI, 34.3–40.8; SD, 23.2) (range, 0–87) days.

Table 1 shows the findings of ultrasound examination compared with laparoscopy. There was a good overall level of agreement between ultrasound examination and laparoscopy in identifying absent, minimal, mild, moderate and severe disease (quadratic weighted kappa = 0.786, standard error (Kw′ = 0) = 0.068, standard error (Kw′#0) = 0.033).

The sensitivity, specificity, LR+ and LR− of TVS in diagnosing pelvic endometriosis are shown in Table 2. Table 3 shows the accuracy of Examiners A and B for detecting severe pelvic endometriosis. There was no significant difference found in overall accuracy between these two examiners when the area under the receiver–operating characteristics (ROC) curve was compared. The numbers of women examined by

Table 1 Comparison of ultrasound and laparoscopic assessment of severity of pelvic endometriosis using the American Society for Reproductive Medicine classification

	Laparoscopy					
Ultrasound	*Absent*	*Minimal*	*Mild*	*Moderate*	*Severe*	*Total*
Absent	59	29	27	3	2	120 (59.7)
Minimal	0	1	0	0	0	1 (0.5)
Mild	1	1	4	2	1	9 (4.5)
Moderate	2	1	0	20	4	27 (13.4)
Severe	0	1	0	2	41	44 (21.9)
Total (%)	62 (30.8)	33 (16.4)	31 (15.4)	27 (13.4)	48 (23.9)	201 (100)

Data are expressed as *n* or as *n* (%).

Table 2 Accuracy of ultrasound in diagnosing different stages of pelvic endometriosis using laparoscopy as the gold standard

	Sensitivity (n (%, 95% CI))	*Specificity* (n (%, 95% CI))	*LR+* (95% CI)	*LR−* (95% CI)
Absent vs. present	78/139 (56.1, 47.8–64.1)	59/62 (95.2, 86.7–98.3)	11.60 (3.81–35.32)	0.461 (0.379–0.561)
Absent to mild vs. moderate to severe	67/75 (89.3, 80.3–94.5)	122/126 (96.8, 92.1–98.8)	28.14 (10.69–74.0)	0.11 (0.057–0.212)
Absent to moderate vs. severe	41/48 (85.4, 72.8–92.8)	150/153 (98.0, 94.4–99.3)	43.5 (14.12–134.39)	0.149 (0.075–0.295)

LR+, positive likelihood ratio; LR−, negative likelihood ratio.

Table 3 Comparison of performance of Examiners A and B at diagnosing severe pelvic endometriosis using ultrasound, with laparoscopy as the gold standard

	Examiner A	*Examiner B*
Sensitivity (%)	81.8 (47.7–96.8)	93.3 (78.7–98.2)
Specificity (%)	98.9 (93.3–99.9)	97.4 (86.5–99.5)
LR+	76.1 (10.6–545)	33.4 (4.82–231)
LR−	0.184 (0.0524–0.644)	0.099 (0.0339–0.292)
PPV (%)	89.8	96.6
NPV (%)	97.8	94.9
Accuracy (AUC)*	0.904	0.938

Data shown in parenthesis are 95% CI. *Comparison of area under receiver–operating characteristics curves (AUC), $P = 0.627$. LR+, positive likelihood ratio; LR−, negative likelihood ratio; NPV, negative predictive value; PPV, positive predictive value.

Examiners C and D were not sufficient to make individual comparisons of accuracy meaningful and therefore the results of these examiners are not presented in Table 3.

The 17 cases of mild disease where DIE was present included the uterosacral ligaments in 12 (70.6%; 95% CI, 46.8–86.7), pelvic side wall in four (23.5%; 95% CI, 9.6–47.3), uterovesical fold/bladder in two (11.8%, 95% CI, 3.3–34.3), pararectal space in one (5.9%; 95% CI, 1.1–27.0), rectovaginal septum in one (5.9%; 95% CI, 1.1–27.0) and rectum in one (5.9%; 95% CI, 1.1–27.0). Thirteen (76.5%; 95% CI, 52.7–90.4) cases had one site of DIE and the other four (23.5%; 95% CI, 9.6–47.3) had two sites. Only one case, involving the bladder, was correctly diagnosed as having DIE on TVS. Table 4 shows the prevalence of DIE, and TVS sensitivity for DIE, in relation to severity as classified by the ASRM classification. It also shows that DIE becomes more prevalent with increasing severity of disease, and the sensitivity of TVS at diagnosing DIE increases with severity of endometriosis.

Table 5 shows the sensitivity, specificity, LR+ and LR−, and areas under the ROC curves, for the diagnosis of: DIE involving the bladder and uterovesical fold; DIE of the rectovaginal septum and bowel; and complete obliteration of the pouch of Douglas. Histological confirmation of endometriosis was not possible in all cases because the study design did not state that histology was necessary. However, where available, the histology results are shown in Table 6. Table 7 shows the distribution of the individual features of endometriosis according to the overall stage of disease.

Figure 1 demonstrates correlation of ultrasound and laparoscopic assessment of the severity of pelvic endometriosis as classified by ASRM. The intermethod correlation coefficient was 0.867 (95% CI, 0.829–0.898). The mean difference between TVS and laparoscopy in assessing severity of endometriosis was −2.398 (95% CI, −4.685 to −0.1112) and the limits of agreement were −34.62 (95% CI, −38.54 to −30.709) to 29.83 (95% CI, 25.91–33.74). The difference is normally distributed as 95% of the values lie within 1.96 SD of the mean. Visual inspection of the scatterplot revealed that the magnitude of the difference did not change with increasing severity of endometriosis (Figure 2).

There were seven false-negative cases for severe endometriosis: two were diagnosed as no endometriosis, one as mild disease and four as moderate disease. The two cases of severe endometriosis that were classified as not having endometriosis both had the pouch of Douglas correctly classified as partially or completely obliterated by adhesions but the endometriotic nodules were not seen

Table 4 Prevalence of deeply invasive endometriosis (DIE) and transvaginal ultrasound sensitivity for detection of DIE, in relation to severity classified using the American Society for Reproductive Medicine (ASRM) classification

	Severity as classified by the ASRM score at laparoscopy				
	Absent	*Minimal*	*Mild*	*Moderate*	*Severe*
Total cases	62	33	31	27	48
DIE prevalence	0 (0, 0–5.8)	0 (0, 0–10.4)	17 (54.8, 35.2–67.5)	17 (63.0, 44.2–78.5)	37 (77.1, 63.5–86.7)
Sensitivity	NA	NA	1/17 (5.9, 1.1–27.0)	6/17 (35.3, 17.3–58.7)	18/37 (48.7, 33.5–64.1)

Data are given as *n* or *n* (%, 95% CI). NA, not applicable.

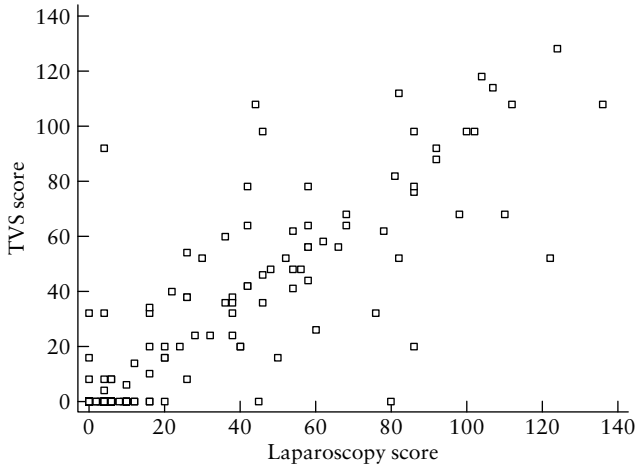

Figure 1 Scatterplot of transvaginal ultrasound (TVS) and laparoscopic findings in individual women with and without evidence of pelvic endometriosis. Severity of the disease was determined using the American Society for Reproductive Medicine (ASRM) classification. Sample size, $n = 201$; correlation coefficient $r = 0.8677$; 95% CI for $r = 0.8289–0.8982$; $P < 0.0001$.

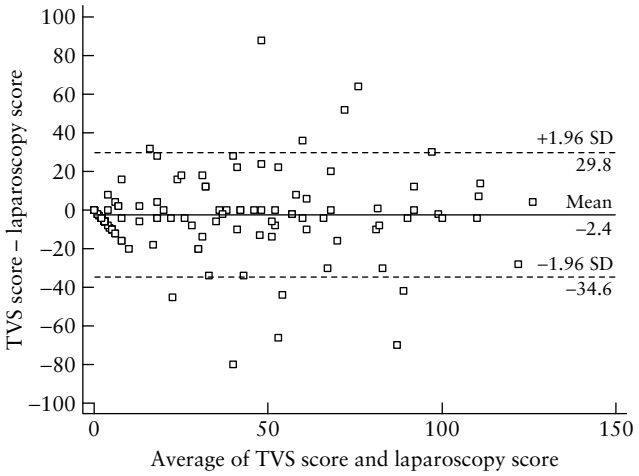

Figure 2 Scatterplot of the difference in American Society for Reproductive Medicine (ASRM) score of severity of endometriosis between transvaginal ultrasound (TVS) and laparoscopy vs. mean score.

and there were no ovarian endometriomas present. These cases were correctly classified as having severe adhesions but not as a consequence of endometriosis. The one case of severe disease that was classified as having mild endometriosis had a rectovaginal septum nodule with an obliterated pouch of Douglas which was not seen on TVS. Of the four cases of severe disease that were diagnosed as moderate disease, three had the pouch of Douglas incorrectly classified as partially obliterated when it was completely obliterated and the other case had ovaries that were fixed when they were classified as mobile. Three cases were false positive for severe endometriosis: one had minimal disease and the other two had moderate disease. The minimal case had the pouch of Douglas misclassified as obliterated. One of the moderate cases had smaller ovarian endometriomas at laparoscopy than on TVS and the other had a unilateral endometrioma on laparoscopy when there were bilateral cysts on TVS. There were 29 cases of minimal disease and 27 cases of mild disease which were falsely diagnosed on TVS as having no disease. The majority of these cases had superficial peritoneal disease only.

DISCUSSION

Our study confirms that TVS is an accurate diagnostic method for the assessment of women with suspected pelvic endometriosis. There was a high level of agreement between TVS and laparoscopy in assessing the severity of disease. The accuracy of TVS in diagnosing cases of moderate and severe pelvic endometriosis was 94%. However, the sensitivity of diagnosis in minimal and mild pelvic endometriosis was relatively low, probably because of the small size of lesions in these cases. The false-negative results in cases of moderate or severe disease occurred as a result of difficulty in identifying DIE and in classifying pouch of Douglas obliteration, a limitation also noted by Bazot[21]. He also reported a high specificity, but a low sensitivity, of diagnosing DIE involving the RVS[10]. The findings were similar in our study, confirming the difficulty in identifying these lesions.

Some authors have advocated transrectal scans in order to improve the ultrasound diagnosis of DIE. This technique was particularly helpful for the diagnosis of uterosacral and intestinal endometriosis[6,7,22,23]. However, Bazot *et al.*[5] achieved better diagnosis of uterosacral and rectosigmoid endometriosis using TVS compared with the transrectal approach. They also showed that TVS is very accurate in the diagnosis of intestinal and bladder endometriosis, but less so in detecting uterosacral, vaginal and rectovaginal septum involvement[21]. Our results

Table 5 Diagnostic accuracy of transvaginal ultrasound (TVS) in the assessment of features of severe endometriosis not clearly scored using the American Society for Reproductive Medicine classification

Feature	*Sensitivity* (n (%, 95% CI))	*Specificity* (n (%, 95% CI))	*LR+* (95% CI)	*LR−* (95% CI)	*AUC (95% CI) with P*
DIE of bladder or uterovesical fold	5/9 (55.56, 21.4–86.0)	192/192 (100, 98.1–100)	N/A	0.44 (0.214–0.923)	0.778 (0.714–0.833) ($P = 0.0027$)
DIE of rectovaginal septum or rectum/sigmoid	14/31 (45.16, 27.3–64.0)	170/170 (100, 97.8–100)	N/A	0.55 (0.398–0.755)	0.726 (0.659–0.786) ($P = 0.0001$)
Obliterated pouch of Douglas	18/25 (72.00, 50.6–87.9)	171/176 (97.16, 93.4–99.0)	25.06 (10.32–62.2)	0.29 (0.154–0.541)	0.846 (0.788–0.893) ($P = 0.0001$)
Any of these features	23/38 (60.53, 43.4–75.9)	156/163 (95.71, 91.3–98.2)	14.09 (6.53–30.41)	0.412 (0.278–0.612)	0.781 (0.718–0.836) ($P = 0.0001$)

AUC, area under the receiver–operating characteristics curve; DIE, deeply invasive endometriosis; LR+, positive likelihood ratio; LR−, negative likelihood ratio.

are concordant with their findings as we also experienced difficulties in identifying endometriosis in the rectovaginal septum. Hudelist[8] found that combining TVS with bimanual examination gave higher levels of accuracy than did bimanual examination alone. We did not perform digital examinations in our study and therefore our sensitivities might be increased using a combined technique. Abrao[3] compared TVS with digital vaginal examination and MRI and found that TVS had better sensitivity, specificity and accuracy in cases of deep 'retrocervical' and rectosigmoid endometriosis when compared with the other two techniques.

Okaro[24] assessed ovarian mobility, in terms of being either mobile or fixed, with a good level of accuracy. We agree with their findings; however, our study could be criticized for using a subjective distinction between the levels of ovarian adhesions, which may be a source of bias. Interobserver reproducibility of these subjective criteria has yet to be evaluated in further studies.

The ASRM classification of severe endometriosis, used in our study, has been criticized for not providing an accurate description of deep infiltrating endometriosis[25]. Although other systems have been developed to complement the ASRM system, these are not widely known and they are rarely used in routine clinical practice[26]. We therefore recommend stating the exact site and extent of any DIE found on either TVS or at surgery in addition to using the ASRM scoring system.

The presence of DIE on the bladder, bowel or RVS, or obliteration of the pouch of Douglas, warrants surgery by an expert laparoscopic surgeon. The presence of any of these features could be used as an alternative way of diagnosing severe endometriosis. The sensitivity of detecting these features varies in our study, but the specificity was very high.

Histological diagnosis was not a condition of inclusion into this study and biopsies were not sent for analysis in all cases. However, when biopsies were sent for analysis in moderate or severe cases, endometriosis was confirmed. Endometriosis was confirmed in 77.8% of mild cases when histology was available.

Ultrasound examinations in this study were performed by operators with a high level of expertise in gynecological ultrasonography. There was no significant difference in diagnostic accuracy between the two operators who performed the majority of ultrasound examinations in this study. This indicates that the ultrasound features of endometriosis are likely to be reproducible with good interobserver agreement. However, the reproducibility of ultrasound in assessing morphological features of pelvic endometriosis needs to be examined further in a prospective study. It remains to be seen whether the accuracy of ultrasound diagnosis of endometriosis will remain high when the examinations are performed by less experienced operators in other centers.

Guerriero *et al.*[27] studied a novel technique for diagnosing vaginal and RVS deep endometriosis using

Table 6 Histological confirmation of endometriosis in relation to severity as classified according to the American Society for Reproductive Medicine (ASRM)

	Severity as classified by the ASRM score at laparoscopy				
Characteristics	*Absent*	*Minimal*	*Mild*	*Moderate*	*Severe*
Total cases	62	33	31	27	48
Histology available	9 (14.5, 7.8–25.3)	3 (9.1, 3.1–23.6)	9 (29.0, 16.1–46.6)	25 (92.6, 76.6–97.9))	44 (91.7, 80.5–96.7)
Endometriosis confirmed	0 (0, 0–29.9)	3 (100, 43.9–100)	7 (77.8, 45–93.7)	25 (100, 86.7–100)	44 (100, 92.0–100)

Data are expressed as *n* or *n* (%, 95% CI).

Table 7 Distribution of features of endometriosis in relation to laparoscopic stage of disease according to the American Society for Reproductive Medicine (ASRM) classification

	Severity as classified by the ASRM score at laparoscopy			
Feature found at surgery	*Minimal* (n = *33*)	*Mild* (n = *31*)	*Moderate* (n = *27*)	*Severe* (n = *48*)
Superficial peritoneal	33	22	16	28
Deep peritoneal	0	17	17	37
No endometriotic cysts	33	31	11	11
Largest cyst < 1 cm	0	0	0	0
Largest cyst 1–3 cm	0	0	11	16
Largest cyst > 3 cm	0	0	5	21
Partial POD obliteration	0	0	7	12
Complete POD obliteration	0	0	0	24
Minimal ovarian adhesions	0	4	1	0
Moderate ovarian adhesions	0	1	5	4
Fixed ovaries	0	1	14	41
Tubal adhesions	0	0	0	7
Tubal dilatation	0	2	0	2

POD, pouch of Douglas.

extra gel to create a stand-off to visualize the near-field area. They concluded that this was an accurate and inexpensive technique for evaluating patients for deep endometriosis. This technique may have benefits over the standard TVS routines, but a direct comparison would be required in order to conclude that this technique is superior. Our study, however, differs from previously published research in that we were attempting to establish the ability of TVS to give an overall assessment of the severity of pelvic endometriosis, rather than trying to examine the accuracy in diagnosing individual morphological features of the disease.

Zanardi *et al.*[28] examined the value of MRI for staging of pelvic endometriosis. This study used a scoring system based on the ASRM classification with modifications to allow for MRI interpretation. They found a high degree of agreement between the MRI findings and operative findings. The authors recognized, however, that MRI is not a good test for diagnosing adhesions or complete obliteration of the pouch of Douglas. In some cases endometriotic nodules were not seen on MRI, and superficial disease was almost impossible to assess, which is similar to the results of our study, using TVS. Although it is clear that both MRI and TVS are, to some extent, limited in the assessment of pelvic endometriosis, the ability of TVS to establish the presence of adhesions directly using dynamic manipulation of the pelvic organs may be an important advantage over MRI.

In conclusion, our study has shown that a targeted TVS scan is an accurate test for the diagnosis of severe pelvic endometriosis. This implies that, in women with evidence of severe disease on ultrasound examination, a confirmatory diagnostic laparoscopy may not be required and these women could be referred directly to a surgical expert in minimally invasive endometriosis, locally, or at a regional tertiary referral endometriosis center. This approach could facilitate more effective triaging of women with severe endometriosis, resulting in shorter, safer, more rational and cost-effective management.

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