Deep Infiltrating Endometriosis

Comparison Between 2-Dimensional Ultrasonography (US), 3-Dimensional US, and Magnetic Resonance Imaging

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Abbreviations

AUC, area under the curve; LR, likelihood ratio; MRI, magnetic resonance imaging; NPV, negative predictive value; PPV, positive predictive value; ROC, receiver operating characteristic; 3D, 3-dimensional; 2D, 2-dimensional; US, ultrasonography

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Objectives—To evaluate the diagnostic accuracy of 2-dimensional (2D) and 3-dimensional (3D) transvaginal ultrasonography (US) in comparison with magnetic resonance imaging (MRI) for identification of deep infiltrating endometriosis.

Methods—In this prospective observational study, 159 premenopausal women who underwent surgery for a clinical suspicion of deep infiltrating endometriosis were prospectively enrolled. All women underwent 2DUS, 3DUS, and MRI. The following 3 locations of deep endometriosis were considered: (1) intestinal; (2) other posterior lesions (retrocervical septum, rectovaginal septum, uterosacral ligaments, and vaginal fornix); and (3) anterior. The sensitivity, specificity, positive predictive value, and negative predictive value of 2D and 3D transvaginal US in comparison with MRI were determined.

Results—Intestinal deep infiltrating endometriosis was identified by 2DUS in 56 of 66 patients, by 3DUS in 59 of 66, and by MRI in 61 of 66. A receiver operating characteristic curve analysis showed optimal results for 2DUS, 3DUS, and MRI (areas under the curve, 0.86, 0.915, and 0.935, respectively) with a statistically significant difference between 2DUS and MRI ($P = .0103$), even when the 95% confidence interval showed an overlap. Other posterior deep infiltrating endometriosis was identified by 2DUS in 55 of 75 patients, by 3DUS in 65 of 75, and by MRI in 66 of 75. A receiver operating characteristic curve analysis showed very good results for 2DUS, 3DUS, and MRI (areas under the curve, 0.801, 0.838, and 0.857) with no statistically significant differences. In the 12 women with deep infiltrating endometriosis in the anterior location, the nodules were correctly identified by 2DUS in 3 of 12 patients, by 3DUS in 5 of 12, and by MRI in 6 of 12.

Conclusions—Our results seem to suggest that there is a statistically significant difference between 2DUS and MRI for the intestinal location of deep infiltrating endometriosis, whereas no differences were found among the techniques for the other locations.

Key Words—endometriosis; gynecology; magnetic resonance imaging; 3-dimensional ultrasound; ultrasonography

Endometriosis is a condition in which endometrial cells are localized outside the uterus, and it affects up to the 10% of women of childbearing age.[1] This condition, particularly the so-called deep infiltrating endometriosis (involvement of retrocervical septum, rectovaginal septum, uterosacral ligaments, vaginal fornix, and bladder), represents a substantial problem because of the associated pain and reduction of fertility[2]; therefore, early diagnosis is considered a critical step for choosing the correct therapeutic approach.

Nowadays, the imaging techniques that are considered the best modalities for detecting and characterizing endometriosis are transvaginal ultrasonography (US) and magnetic resonance imaging (MRI).[3,4] The role of computed tomography is reduced because of the radiation dose delivered to the patient during the procedure.[5] In past years, several studies have demonstrated the overall value of 2-dimensional (2D) US for detection of deep infiltrating endometriosis,[6] particularly when dedicated approaches, such as the "tenderness-guided" approach, are used.[7,8] However, the value of 2DUS is still debated, particularly for some challenging locations such as the uterosacral ligaments.

The 3-dimensional (3D) technology is relatively new, but some studies have shown that this approach could guarantee better performance[9,10] compared with 2DUS, with the advantage of exploring the images offline and by allowing multiple readers to study the US data.[11]

The other imaging technique used to detect endometriosis is MRI[12–14]. The value of MRI has been validated by several studies in the last 10 years by confirming the potentiality of identifying small nodules of endometriosis in locations traditionally considered challenging for US.[15–17] One of the advantages of MRI is its better interobserver and intraobserver agreement, even if some recent publications also pointed out how the level of expertise plays a fundamental role in its diagnostic performance.[18,19]

In this study, we aimed to compare the diagnostic accuracy, sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of 2DUS, 3DUS, and MRI in patients with suspected deep infiltrating endometriosis who underwent surgery. Moreover, receiver operating characteristic (ROC) curve analyses were also performed.

Materials and Methods

Study Population

All premenopausal patients who underwent surgery for a clinical suspicion of deep infiltrating endometriosis in our department from January 2007 to November 2012 were prospectively included. A power analysis calculation was performed, and to obtain a statistically significant difference in sensitivity and specificity between 80% and 95% (by considering a type I error α of .05 and a type II error β of .05), we found that at least 150 patients should be recruited.

As previously reported in another publication,[17] we considered the following as exclusion criteria: (1) identification of an ovarian mass larger than 10 cm because of the potential distortion of pelvic tissues; (2) patients who had not undergone 2DUS, 3DUS, or MRI; (3) insufficient surgical or pathologic descriptions; (4) pregnant women; (5) time between 2DUS/3DUS and MRI longer than 30 days; (6) time between surgery and imaging longer than 30 days; and (7) women younger than 18 years.

At the time of the examinations, 32 patients were being treated with estrogen or progestin, and 7 were using gonadotropin-releasing hormone analogs. A portion of the data presented in this study was already used in previously published articles.[17,20] This study was approved by the Institutional Review Board, and all of the patients gave written informed consent.

Magnetic Resonance Imaging Technique

A Gyroscan 1.5-T superconducting magnet (Philips Healthcare, Best, the Netherlands) was used for all examinations. To reduce intestinal peristalsis, the patients were asked to have a bowel movement and to fast for 3 hours before the MRI. Fifteen minutes before the examination, 20 mg of hyoscine butylbromide (Buscopan; Boehringer Ingelheim, Higashine, Japan) was administered intramuscularly. A body coil was used, and 3 T2-weighted sequences (repetition time, 4000 milliseconds; echo time, 90 milliseconds; matrix, 256 × 512; section thickness, 4–5 mm; and field of view, 32 cm) in different slice orientations (sagittal, coronal, and axial planes), followed by 3 T1-weighted sequences in an identical imaging plane (repetition time, 500 milliseconds; echo time, 14 milliseconds; matrix, 256 × 512; section thickness, 4–5 mm; and field of view, 32 cm), were performed. Native T1-weighted sequences without fat suppression and fat-suppressed T1-weighted sequences before and after intravenous injection of a gadolinium contrast media (gadopentetate dimeglumine, 0.1 mL/kg of body weight [Magnevist; Bayer Schering Pharma AG, Berlin, Germany]) were also performed.

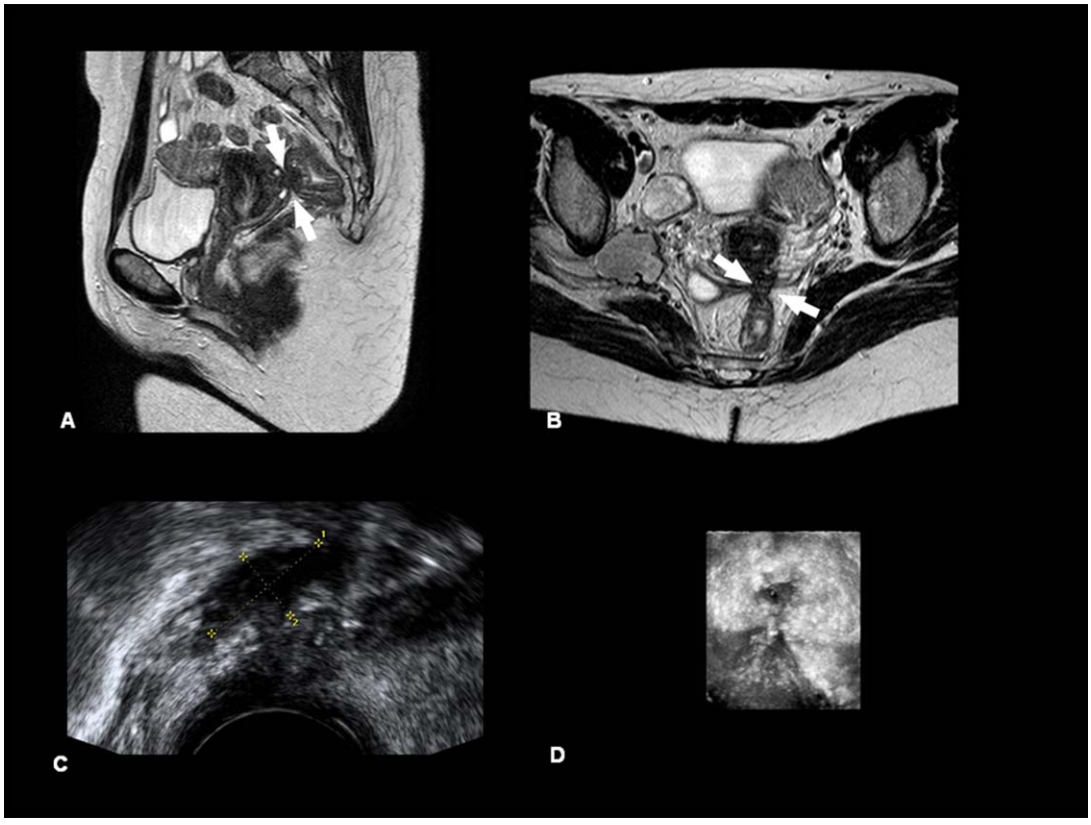
Each data set was reviewed by a single expert reader (L.S., with 9 years of experience in female pelvic imaging) for the presence of endometriosis (Figures 1–3). F1-F3 The observer was blinded to the 2DUS and 3DUS results.

Two- and Three-Dimensional US Technique

All patients underwent 2DUS and 3DUS examinations on the same day. The examinations were performed by a single experienced operator (with 23 years of experience in gynecologic US) with Voluson I equipment (GE Healthcare, Milwaukee, WI) equipped with a transvaginal transducer with a frequency of 5 to 9 MHz (online supplemental Figures 1–7). Detailed descriptions of the 2DUS and 3DUS were presented in previously published articles.[7,8,10] Briefly, 2DUS was performed with an acoustic window between the transvaginal transducer and the surrounding vaginal structures by increasing the amount of US gel inside the transducer cover, coupled with an "active" role of the patient, who indicated the site of any tenderness felt during the examination. The diagnosis of deep pelvic endometriosis was made according to criteria that varied in relation to the anatomic location: the colon (rectum/sigmoid) was involved when an irregular hypoechoic mass with or without hypoechoic or hyperechoic foci was detected, whereas involvement of the vagina (retrocervical nodule) was suspected when the posterior vaginal fornix was thickened, with or without cystic anechoic areas around it. The presence of endometriosis involving the rectovaginal septum was suspected when a nodule below a horizontal plane passing along the lower margin of the posterior lip of the cervix (under the peritoneum) was found. Typical images of bladder involvement are characterized by the presence, in the context of its wall, of nodules and/or isoechoic or hypoechoic cystic lesions. The uterosacral ligament was considered to be involved when a nodule was visible (regular or irregular margins) or when linear hypoechoic thickening with regular or irregular margins was detected.

After the 2DUS examination, patients underwent a 3DUS analysis with the same US equipment. The obtained volume was stored on the hard disk and displayed later with special software (4D View; GE Healthcare). All 3DUS images were assessed in the sagittal and coronal planes and with 3D rendering using a virtual

Figure 1. Rectosigmoid lesion as visualized on MRI (**A** and **B**), 2DUS (**C**), and 3DUS (**D**) in 32-year-old patient. In the MRI panels, the white arrows show the presence of a hypointense nodule in contact with the sigma and an hourglass appearance.



navigation approach. On the 3D rendering, rectosigmoid lesions typically appear as spiculated lesions with a retracting line all around the nodule, whereas uterosacral ligament lesions show a nodular or plaque shape laterally to the uterine torus.

Imaging Analysis

In this study, the lesions were grouped into 3 distinct locations: (1) intestinal, including the rectosigmoid (Figure 1); (2) other posterior, including lesions at the level of the uterosacral ligament, retrocervical or rectovaginal septum, and vaginal fornix (Figure 2); and (3) anterior, indicating involvement of the bladder wall (Figure 3).

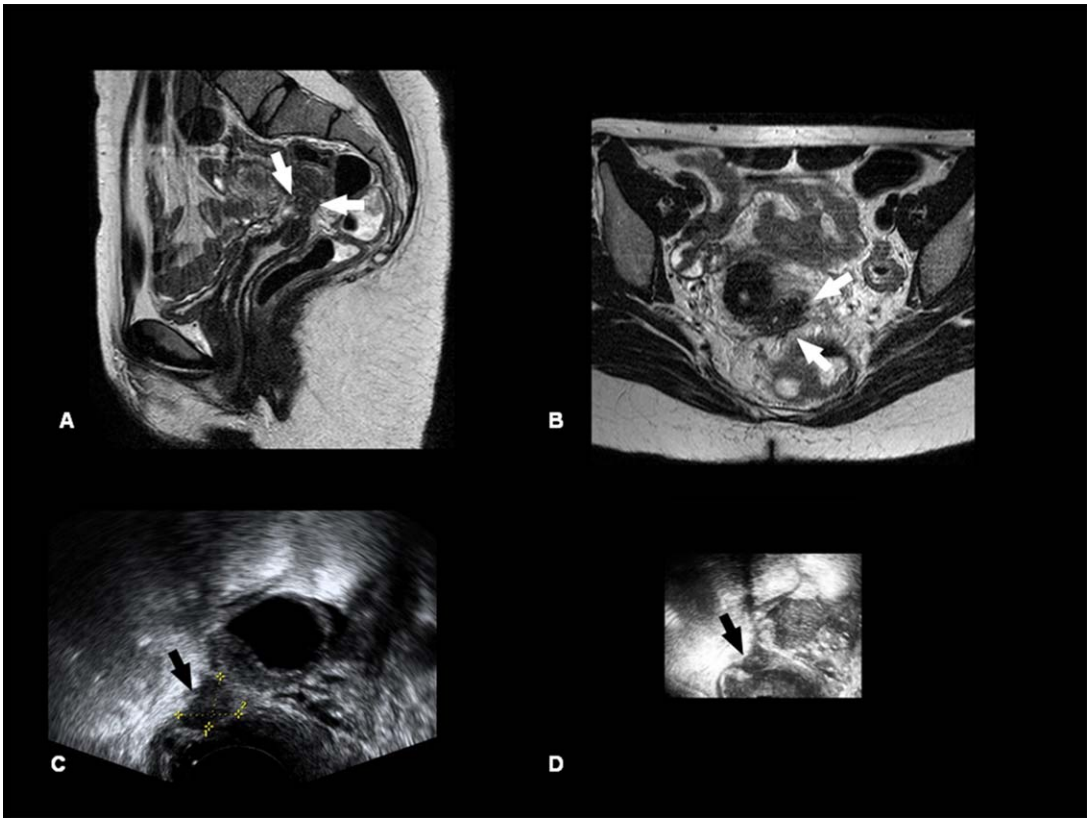
Surgical Evaluation

The reference analysis for this study was the surgery, which was performed by different operators over the 5 years of analysis. The surgical charts were reviewed to confirm the presence of deep infiltrating endometriosis in the 3 selected locations according to the rules suggested by Bazot et al[21] in 2004: (1) direct visualization of the lesion, attributable to deep endometriosis; and (2) complete obliteration of the pouch of Douglas, with a secondary observation of other locations of deep endometriosis.

Statistical Analyses

Receiver operating characteristic curve analyses were performed and the area under the curve (AUC) values were calculated; moreover, comparisons between the AUC values were calculated. The sensitivity, specificity, PPV, NPV, accuracy, positive likelihood ratio (LR), and negative LR were calculated. In addition, the McNemar test was used to check the equality of the sensitivity and specificity of the 3 tests by comparing 2 modes at time. $P < .05$ was regarded as indicating a statistically significant association, and all values were calculated at a 2-tailed significance level. The posttest probability was also calculated. Statistical analyses were performed with the

Figure 2. Vaginal forniceal lesion as visualized on MRI (**A** and **B**), 2DUS (**C**), and 3DUS (**D**) in a 27-year-old patient. In the MRI panels, the white arrows show the presence of a hypointense nodule with involvement of the fornix. In the US panels, the black arrows confirm the presence of a hypoechoic nodule.



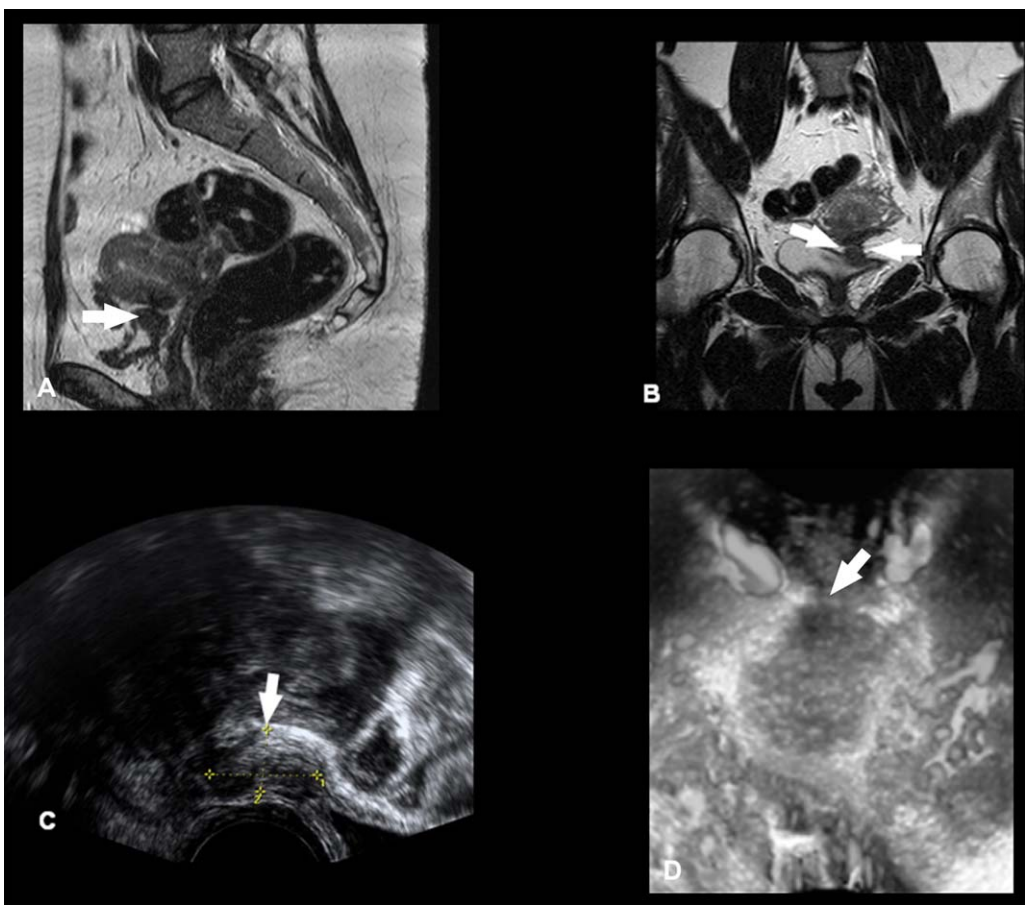
SPSS version 18.0 statistical package (IBM Corporation, Armonk, NY). Graphics were plotted with MedCalc 9.0 software (MedCalc, Mariakerke, Belgium).

Results

One hundred fifty-nine women (mean age ± SD, 33 ± 7 years; range, 18–54 years) were included in the study. In all 159 patients, a laparoscopic approach was performed. Surgery found the presence of deep infiltrating endometriosis in 105 patients (66% of the total). A single nodule of endometriosis was found in 61 patients (38% of the total), while 45 patients had more than 1 location (28% of the total). Deep infiltrating endometriosis involving the intestinal location was found in 66 women (prevalence of 42%), other posterior locations in 75 (prevalence of 47%), and the anterior compartment in 12 (prevalence of 7%).

The surgical analysis showed that in 66 of the 159 women, endometriosis was present in in intestinal location, and the nodules were correctly identified by 2DUS in 56 of 66 patients, by 3DUS in 59 of 66, and by MRI in 61 of 66. The receiver operating characteristic curve analysis (Figure 4) showed optimal results for 2DUS, 3DUS, and MRI (AUC, 0.86, 0.915, and 0.935, respectively) with a statistically significant difference between 2DUS and MRI ($P = .0103$). In 42 patients, the intestinal location was associated with nodules of endometriosis in other areas: in particular, in 40 cases, there was endometriosis in the other posterior locations; in 4 cases, the anterior compartment was involved; and in 2 cases, there was involvement of all 3 locations. The

Figure 3. Bladder lesion as visualized on MRI (**A** and **B**), 2DUS (**C**), and 3DUS (**D**) in a 27-year-old patient. White arrows show the presence of a nodule of endometriosis involving the bladder wall.



sensitivity, specificity, PPV, NPV, positive LR, and negative LR for the intestinal location are given in the Table 1. The pretest probability of intestinal involvement was 42%, and this probability increased with the use of 2DUS, 3DUS, and MRI up to 82%, 91%, and 92%, respectively, when the result was positive and reduced to 11%, 7%, and 5% when the result was negative. The McNemar test did not show a statistically significant difference in the intestinal location (2DUS versus 3DUS, 2DUS versus MRI, and 3DUS versus MRI: $P = .691$, .838, and .996).

In the 75 women with deep infiltrating endometriosis in the other posterior locations the nodules were correctly identified by 2DUS in 55 of 75 patients, by 3DUS in 65 of 75, and by MRI in 66 of 75. The ROC curve analysis (Figure 5) showed very good results for 2DUS, 3DUS, and MRI (AUC, 0.801, 0.838, and 0.857, respectively) with no statistically significant differences. The sensitivity, specificity, PPV, NPV, positive LR, and negative LR for other posterior locations are given in the Table 2. The pretest probability of other posterior involvement was 47%, and this probability increased with the use of 2DUS, 3DUS, and MRI up to 83%, 80%, and 92%, respectively, when the result was positive and reduced to 22%, 12%, and 11% when the result was negative. The McNemar test showed a statistically significant difference in other posterior locations between 2DUS and 3DUS ($P = .0093$) and between 2DUS and MRI ($P = .0108$); no difference was found between 3DUS and MRI ($P = .987$).

In the 12 women with deep infiltrating endometriosis in the anterior location, the nodules were correctly identified by 2DUS in 3 of 12 patients, by 3DUS in 5 of 12, and by MRI in 6 of 12. The ROC curve analysis (Figure 6) showed very good results for 2DUS, 3DUS, and MRI (AUC, 0.615, 0.698, and 0.736, respectively)

Figure 4. Receiver operating characteristic curve analysis for endometriosis in the intestinal location.

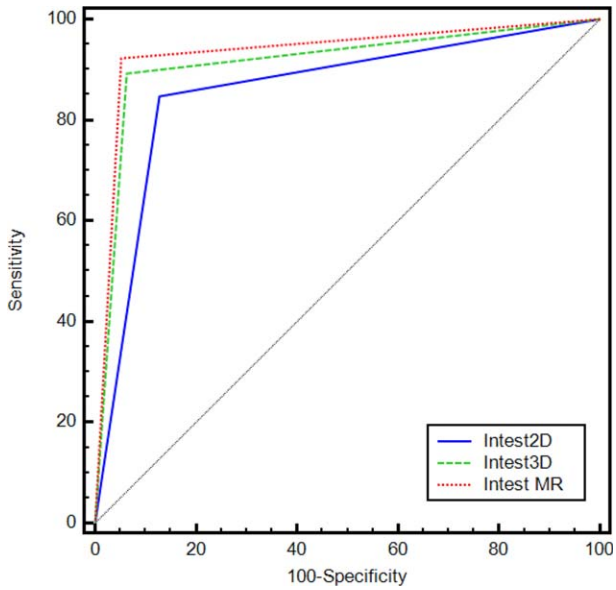


Table 1. Diagnostic Performance of 2DUS, 3DUS, and MRI for Endometriosis in the Intestinal Location

Modality	Sensitivity, % (n)	Specificity, % (n)	PPV, % (n)	NPV, % (n)	LR+	LR−
2DUS	84.8 (56/66) 76.2–93.5	87.10 (81/93) 80.30–93.90	82.40 (56/68) 73.3–91.4	89.0 (81/91) 82.6–95.4	6.576	0.174
3DUS	89.4 (59/66) 82.0–96.8	93.5 (87/93) 88.6–98.5	90.8 (59/65) 83.7–97.8	92.6 (98/94) 87.2–97.9	13.856	0.113
MRI	92.4 (61/66) 86.0–98.8	94.6 (88/93) 90.0–99.2	92.4 (61/66) 86.0–98.2	94.6 (88/93) 90.0–99.2	17.191	0.08

with no statistically significant differences. The sensitivity, specificity, PPV, NPV, positive LR, and negative LR for the anterior location are given in the Table 3. The pretest probability of anterior involvement was 7%, and this probability was increased with the use of 2DUS, 3DUS, and MRI up to 49%, 62%, and 60%, respectively, when the result was positive and reduced to 6%, 5%, and 4% when the result was negative. The McNemar test did not show a statistically significant difference in the anterior location (2DUS versus 3DUS, 2DUS versus MRI, and 3DUS versus MRI: $P = .726$, .289, and .625). The ROC curve areas were also compared to identify statistically significant differences (Table 4).

Discussion

Currently, it is possible to apply different imaging approaches to identify the presence of deep infiltrating endometriosis, and previously published studies have demonstrated the advantages and disadvantages of 2DUS, 3DUS, and MRI.[20,22–24] Some studies have already compared the diagnostic performance of 2DUS versus MRI[16,17,25] and 3DUS versus MRI,[26] but to the best of our knowledge, a comparison of these 3 techniques in the same population has not been explored before. This study tried to address this topic because, in our opinion, a comparison of these techniques in the same population allows an adequate level of homogeneity.

In this research, the prevalence of deep infiltrating endometriosis was 66% (105 of 159), with 38% of the patients having only 1 location involved and 28% having 2 or more locations involved. Our prevalence was similar to that of Hudelist et al[27] (63%) but was significantly lower than that of Bazot et al.[25]

Focusing on the diagnostic performance of 2DUS, 3DUS, and MRI in the 3 locations considered, we found

Figure 5. Receiver operating characteristic curve analysis for endometriosis in other posterior locations.

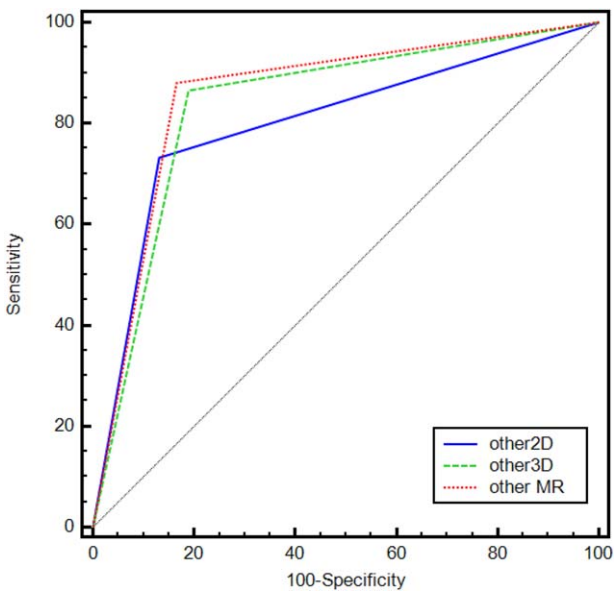


Table 2. Diagnostic Performance of 2DUS, 3DUS, and MRI for Endometriosis in Other Posterior Locations

Modality	Sensitivity, % (n)	Specificity, % (n)	PPV, % (n)	NPV, % (n)	LR+	LR−
2DUS	73.3 (55/75) 63.3–83.3	86.9 (73/84) 77.9–94.1	83.3 (55/66) 74.3–92.3	78.5 (73/93) 70.1–86.8	5.60	0.307
3DUS	86.7 (65/75) 79.0–94.4	81.0 (68/84) 72.6–89.3	80.2 (65/81) 71.6–88.9	87.2 (68/78) 79.8–94.6	4.55	0.165
MRI	88.0 (66/75) 80.6–95.4	83.3 (70/84) 75.4–91.3	82.5 (66/80) 74.2–90.8	88.6 (70/79) 81.6–95.6	5.28	0.144

that in the intestinal location, MRI correctly detected the highest number of nodules (61 of 66). In the intestinal location, better sensitivity was obtained with MRI (92.4%), followed by 3DUS and 2DUS (89.4% and 84.8%, respectively); these results were a little different from the results we obtained in a previously published study,[24] in which the sensitivity for detection of intestinal involvement on 3DUS and 2DUS were 95% and 91%. Therefore, in this study, better performance was found for 3DUS (but 2DUS, as in the previously published study[24]). This difference could be explained by the effect of a "learning curve" in the use of the 3DUS technology because the sonographer acquired optimal expertise in 3DUS imaging and, in particular, in the use of the software for analysis that was not reached in the study published in 2014.[24] However, more interesting was the reduction in the performance of the 2DUS technique. We tried to understand the reasons of this reduced performance, and our opinion is that different nodule sizes played a role: in the 2014 study,[24] the size of the nodules was 17 ± 9 mm (range, 4–51 mm), whereas in the cohort analyzed in this study, it was 15 ± 8 mm (range, 4–53 mm). Similar trends were also found for the other intestinal locations and for the anterior location. In our study, ROC curve analyses showed optimal values for 2DUS, 3DUS, and MRI with a statistically significant difference ($P = .0103$) between 2DUS and MRI; however, the McNemar test did not show significant differences among these techniques. The sensitivity showed different performances for 2DUS, 3DUS, and MRI (84.8%, 89.4%, and 92.4% respectively). Comparison of these data with the literature is quite complex because of the wide time range of publication of the articles and the different methods used.[28,29] In our cohort, the prevalence was 41.5%, whereas Abrão et al[30] found a rate of 94%, and Bazot et al[25] found a rate of

Figure 6. Receiver operating characteristic curve analysis for endometriosis in the anterior location.

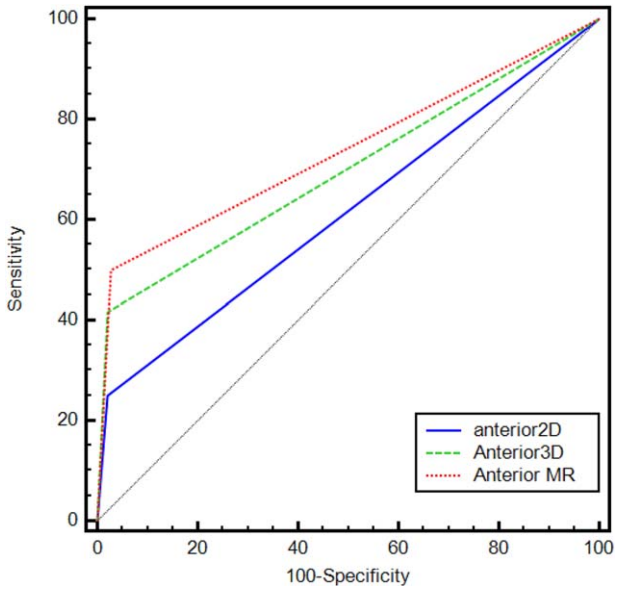


Table 3. Diagnostic Performance of 2DUS, 3DUS, and MRI for Endometriosis in the Anterior Location

Modality	Sensitivity, % (n)	Specificity, % (n)	PPV, % (n)	NPV, % (n)	LR+	LR−
2DUS	25.0 (3/12) 0.5–49.5	98.0 (144/147) 95.7–100	50.0 (3/6) 10.0–90.0	94.0 (144/153) 90.4–97.8	12.25	0.766
3DUS	41.7 (5/12) 13.8–69.6	98.0 (144/147) 95.7–100	62.5 (5/8) 29.0–96.0	95.4 (144/151) 92.0–98.7	20.41	0.595
MRI	50.0 (6/12) 21.7–78.3	97.3 (143/147) 94.6–99.9	60.0 (6/10) 29.6–90.4	96.0 (132/137) 92.8–99.1	18.37	0.514

Table 4. Comparison of AUC Values of 2DUS, 3DUS, and MRI for Endometriosis in Intestinal, Other, and Anterior Locations

Location	*P*, 2DUS vs 3DUS	*P*, 2DUS vs MRI	*P*, 3DUS vs MRI
Intestinal	.0868	.0103	.0849
Other posterior	.2653	.0757	.0826
Anterior	.1424	.0643	.3632

61%. It is interesting to note that the sensitivity of 2DUS the we found was suboptimal compared with the other techniques, even though the observer had great experience. The 2DUS findings of rectosigmoid endometriosis are the presence of an irregular hypoechoic nodule, with or without hypoechoic or, rarely, hyperechoic foci. The normal appearance of the muscularis propria of the rectal sigma is replaced with a nodule of abnormal tissue, with visible retraction and adhesions in some cases. These findings help identify deep infiltrating endometriosis in this location, but the topography of some nodules could make identification difficult in some cases. The pretest probability of intestinal involvement was 42%, and this probability was increased with the use of 2DUS, 3DUS, and MRI up to 82%, 91%, and 92%, respectively, when the result was positive and reduced to 11%, 7%, and 5% when the result was negative. Saccardi et al,[16] found sensitivity of 66.7% for MRI and 2DUS and specificity of 95.8% and 93.8% for the diagnosis of rectal endometriosis. In a recently published meta-analysis, Guerriero et al[28] found that the overall diagnostic performance of transvaginal US for deep infiltrating endometriosis of the rectosigmoid was good (pooled sensitivity, specificity, positive LR, and negative LR of transvaginal US in the rectosigmoid were 91%, 97%, 33.0, and 0.10) but further studies with improved quality in design are needed because in some cases there are methodological biases. A published MRI meta-analysis by Medeiros et al[31] assessed 20 studies, which included 1819 women, and the authors found that the pooled sensitivity and specificity for the intestine were 0.84 and 0.97, and for the rectosigmoid, they were 0.83 and 0.88. Our study showed better results for MRI compared with the meta-analysis, and we could explain this difference by the fact that the article by Medeiros et al[31] assessed 20 studies that were performed over more than 10 years, and over that timeline, there were substantial improvements in the MRI technique and technology. In summary, according to our results, MRI shows better performance for detection of nodules of endometriosis in intestinal locations, with a statistically significant difference between MRI and 2DUS.

By assessing deep infiltrating endometriosis in the other posterior locations, the ROC curve analysis showed very good results for 2DUS, 3DUS, and MRI with no statistically significant differences. Also, the sensitivity values were good, at 73.3%, 86.7% and 88.0% for 2DUS, 3DUS, and MRI, respectively. No significant difference among the sensitivity was found, and in this case, it is interesting to note that the sensitivities of 3DUS and 2DUS were similar to our previously published values (87% and 71%).[24] These results were quite unexpected because in a previously published study from our group, the AUC values for endometriosis in other posterior locations were significantly different (0.891 [95% confidence interval, 0.839–0.943] for 3DUS versus 0.789 [95% confidence interval, 0.720–0.858 for 2DUS]; $P = .0193$).[24] The pretest probability of other posterior involvement was 47%, and this probability was increased with the use of 2DUS, 3DUS, and MRI up to 83%, 80%, and 22% when the result was positive and reduced to 22%, 12%, and 11% when the result was negative. In a meta-analysis,[29] the authors found that the overall diagnostic performance of 2DUS for detecting deep infiltrating endometriosis in uterosacral ligaments and the rectovaginal septum was fair (53% and 49%) with high specificity (93% and 98%).

In the women with deep infiltrating endometriosis in the anterior location, 2DUS correctly identified these nodules in 3 of 12 patients, and 3DUS correctly identified them in 5, whereas MRI correctly identified them in 6. The sensitivity values were suboptimal, at 25.0%, 41.7%, and 50.0% for 2DUS, 3DUS, and MRI, respectively. Detection of endometriosis involving the anterior location is challenging, and evidence from the literature confirms these data. In the data produced by Medeiros et al[31] the pooled sensitivity of MRI for the bladder was 0.64. In the meta-analysis by Guerriero et al,[28] for detection of bladder endometriosis, the overall pooled sensitivity was 62%; the 2DUS and 3DUS values we found were lower compared with the meta-analysis results, but these findings could be explained by the fact that substantial heterogeneity was found for sensitivity and specificity in all of these locations, and this parameter may have affected the results.

The suboptimal sensitivity was counterbalanced by the very good specificity values (98.0%, 98.0%, and 97.7% for 2DUS, 3DUS, and MRI, respectively), which

explains the good results for 2DUS, 3DUS, and MRI in the ROC curve analysis (AUC, 0.615, 0.698, and 0.736). The low sensitivity could be also explained by the low prevalence of anterior involvement, with pretest probability of 7%. With the use of 2DUS, 3DUS, and MRI, this probability increased up to 49%, 62%, and 60% when the result was positive and reduced to 6%, 5%, and 4% when the result was negative.

We are aware that this study had some limitations. First, it was a single-center study, which could reduce the generalizability of our results. Second, all 159 women underwent surgery performed by different operators over the 5 years of the study; this approach could have introduced a bias in the reference standard. However, it is our opinion that this factor should be considered a minor limitation because all of the surgeons work in a high-volume tertiary center.

In conclusion, our results seem to suggest that there is a statistically significant difference between 2DUS and MRI for the intestinal location of deep infiltrating endometriosis, whereas no differences were found among the techniques for the other locations; however, the McNemar test showed differences in sensitivity and specificity between 2DUS and 3DUS and between 2DUS and MRI in other posterior locations but not in the intestinal and anterior locations.

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