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DR SHANNON REID (Orcid ID : 0000-0003-4227-9559)

DR MERCEDES ESPADA (Orcid ID : 0000-0002-4330-6144)

DR CHUAN LU (Orcid ID : 0000-0002-4898-6679)

PROFESSOR GEORGE CONDOUS (Orcid ID : 0000-0003-3858-3080)

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# To determine the optimal ultrasonographic screening method for rectal/rectosigmoid deep endometriosis: ultrasound "sliding sign", transvaginal ultrasound direct visualization or both?

Shannon Reid[1,2], Mercedes Espada[1], Chuan Lu[3] and George Condous[1,2]

[1]Acute Gynecology, Early Pregnancy and Advanced Endosurgery Unit, Sydney Medical School Nepean, University of Sydney, Nepean Hospital, Penrith, NSW, Australia
[2]OMNI Gynecological Care, Centre for Women's Ultrasound and Early Pregnancy, St Leonards, NSW, Australia
[3]Department of Computer Sciences, Aberystwyth University, Wales, UK

**Correspondence:**
Mercedes Espada
Acute Gynaecology, Early Pregnancy and Advanced Endosurgery Unit, Nepean Hospital
Penrith, NSW, Australia

Email:medimer@hotmail.com

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## ABSTRACT

**Introduction:** The study aim was to evaluate the transvaginal sonography (TVS) "sliding sign" alone, direct visualization of the bowel with TVS, and the combination of both methods (i.e. "sliding sign" *and* direct visualization of the bowel), to determine the optimal TVS method for the prediction of rectal/rectosigmoid deep endometriosis (DE). **Material and methods:** Multicentre prospective observational study (January 2009- February 2017). All women underwent TVS to determine whether the "sliding sign" was positive/negative and whether rectal/rectosigmoid DE was present, followed by laparoscopic surgery. The association between a negative TVS "sliding sign" alone and the direct visualization of a rectal/rectosigmoid DE nodule alone during the TVS were correlated with the presence of rectal/rectosigmoid DE at laparoscopy. Accuracy, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and likelihood ratios were evaluated. Data were analysed using Fisher's exact test. **Results:** During the recruitment period, 410 consecutive women with suspected endometriosis were included. Complete TVS and laparoscopic surgical outcomes were available for 376/410 (91.7%) women. Complete TVS and laparoscopic data were available for 376 women. 76/376 (20.2%) women had rectal/rectosigmoid DE at laparoscopy. The accuracy, sensitivity, specificity, PPV, NPV, positive and negative likelihood ratios for each method to predict bowel DE were: negative "sliding sign": 87%, 73.7%, 90.3%, 65.9%, 93.1%, 7.62, and 0.29, respectively, direct visualization: 91.0%, 86.8%, 92.3%, 74.2%, 96.5%, 11.3, and 0.14, respectively, and combined approach: 90.2%, 69.7%, 95.3%, 79.1%, 92.6%, 14.94 and 0.32, respectively. A negative TVS "sliding sign" was significantly associated with the need for bowel surgery (p-value<0.05). **Conclusions:** The combination of the TVS "sliding sign" and direct

visualization of the bowel during TVS appears to provide the most accurate assessment for the identification of rectal/rectosigmoid DE pre-operatively.

**Abbreviations:**

DE: deep endometriosis

TVS: transvaginal sonography

LR: likelihood ratio

MRI: magnetic resonance imaging

NPV: negative predictive value

POD: pouch of Douglas

PPV: positive predictive value

RVS: rectovaginal septum

USL: uterosacral ligaments

**Keywords**

transvaginal sonography, "sliding sign", deep endometriosis, rectal deep endometriosis, laparoscopy

**Key message**

In expert hands, the combination of direct visualization of rectal/rectosigmoid deep endometriosis at transvaginal sonography and a negative transvaginal sonography "sliding sign" appears to be the most accurate screening method for the prediction of rectal/rectosigmoid deep endometriosis pre-operatively.

## INTRODUCTION

Deep endometriosis (DE) is defined as the presence of endometrial subperitoneal implants of ≥5 mm and can occur in the rectum/rectosigmoid bowel, uterosacral ligaments (USL), rectovaginal septum (RVS), vagina and/or bladder (Guerriero *et al*[1] ). Bowel endometriosis involvement is estimated to occur in 5.3% to 12% of women with endometriosis; the rectum and rectosigmoid junction together account for 70% to 93% of all intestinal endometriotic sites (Chapron *et al.*[2] ).

Transvaginal sonography (TVS) and magnetic resonance imaging (MRI) have been assessed as appropriate mapping tools for DE, ovarian endometriosis and adenomyosis (Hudelist *et al.* [3)]. The use of the TVS "sliding sign" has been demonstrated in previous studies to predict the presence of pouch of Douglas (POD) obliteration in women with suspected endometriosis, with a sensitivity and specificity ranging from 83-89% and 92-97%, respectively (Reid et al. [4,] Leon et al.[5]). POD obliteration at laparoscopy is known to be associated with a three-fold increased risk of DE of the rectum, and in turn, the need for bowel surgery (Khong et al.[6] ).

Given the strong relationship between POD obliteration and rectal/rectosigmoid DE at laparoscopy, it has been suggested that a negative "sliding sign" may be a useful sonographic test for the prediction of rectal DE. In a study by Hudelist et al., a negative TVS "sliding sign" was associated with rectal DE with an accuracy, sensitivity, specificity, PPV, NPV, LR+ and LR- of 93%, 85%, 96%, 91%, 94%, 23.6 and 0.15, respectively (Hudelist[7]). The authors concluded from this study that a negative "sliding sign" could be a useful tool for triaging rectal DE in primary care, where skills in TVS are less developed.

The association between POD obliteration and rectal DE at laparoscopy was also appreciated in a recent publication from our group (Reid et al. [8]); 36/43 (84%) women with rectal DE at surgery were also found to have POD obliteration. The findings from this study suggest that a negative "sliding sign" may not be an accurate predictor of rectal DE, as POD obliteration can occur in the absence of rectal DE (and vice versa).

The aim of the current study was to assess whether the ultrasound-based "sliding sign" alone or direct visualization of rectal DE alone using TVS or the combination of "sliding sign" and direct visualization of rectal DE using TVS is the optimal screening ultrasonographic method for the prediction of rectal DE in women with suspected endometriosis.

## MATERIAL AND METHODS

This was a multicentre prospective observational study undertaken from January 2009 to February 2017, which included 410 women with suspected endometriosis. Women included in this study presented to the tertiary referral pelvic pain clinic with symptoms of chronic pelvic pain +/- history of endometriosis. Informed consent was gained from all women prior to enrolment in the study. All women underwent detailed TVS and laparoscopy within a 6 month time frame. The TVS examinations were carried out at two centres: Nepean Hospital and OMNI Gynaecological Care. The laparoscopic surgeries were performed at nine different hospitals: Nepean, Norwest Private, Royal Hospital for Women, Royal Prince Alfred, Hurstville Private, St. Luke's Private, Prince of Wales Private, Liverpool and St. George Private Hospitals. Ethics approval for this study was obtained by the Human Research Ethics Committee, Sydney West Area Health Service, Nepean campus, Penrith, Australia.

A standardized history, clinical examination, pre-operative TVS (7.5 MHz transvaginal probe (LOGIQ-e -I, General Electric, Zipf, Austria or Medison X8, V20 or XG, Samsung Medison, Seoul, South Korea) was performed for all women prior to laparoscopy. All TVS examinations were completed by one of two operators (GC or SR), both of whom were experienced in performing gynaecological TVS scans for the prediction of pelvic DE. According to the 5-domain sonographically based approach (*Menakaya U., et al*[9]), the next steps were followed simultaneously during the TVS: firstly, the uterus was assessed for position, size and pathology. Secondly, the ovaries were evaluated for size, mobility, and pathology. Site specific tenderness was also assessed. Thirdly, the POD status was appraised using the real time ultrasound-based "sliding sign". A negative TVS "sliding sign" was recorded when the anterior rectum/rectosigmoid bowel did not glide smoothly across the posterior cervix/posterior uterine fundus, respectively (Reid et al.[4], Menakaya et al[9]). Lastly, the examiner performed an evaluation of the anterior and posterior compartments for DE in the bladder/ureters/uterovesical fold/rectum/rectosigmoid, RVS, USLs and vagina.
There were a total of thirteen laparoscopic surgeons who performed the surgical intervention. The gold standard diagnosis of bowel endometriosis was made if there was: 1) a histological confirmation of endometriosis in at least one resected sub-peritoneal rectal/rectosigmoid nodule; or 2) visualisation and palpation of a rectal/rectosigmoid sub-peritoneal nodule without biopsy and another histologically proven location of endometriosis; or 3) visualisation of complete obliteration of cul-de-sac and another histologically proven location

of endometriosis (Bazot et al.[10] ). There were a total of thirteen laparoscopic surgeons who performed the surgical intervention.

The ultrasound and surgical data were entered into a Microsoft Excel 2010 spreadsheet by the primary author (SR) after review of the TVS and operation reports. The surgical findings were reported by each surgeon in the form of detailed text and diagrams.

**Statistical analyses**

Statistical analysis was conducted using R version 3.4.0 (www.r-project.org). Data were analysed to determine the accuracy, sensitivity, specificity, positive (PPV) and negative predictive value (NPV), and positive likelihood ratio (LR(+)) and negative likelihood ratio (LR(–)) with 95% confidence intervals (CI), and p-value of the TVS "sliding sign" to predict rectal DE using Fisher's exact test. A p-value of $<0.05$ was considered statistically significant.

**Ethical approval**

Ethics approval was obtained in November 2016 (HREC code: LNR/16/NEPEAN/16).

**RESULTS**

During the recruitment period, 410 consecutive women with suspected endometriosis were included. Complete TVS and laparoscopic surgical outcomes were available for 376/410 (91.7%) women. Symptom characteristics are shown in Table 1. The most common symptom among the women was dysmenorrhea, followed by dyspareunia. The surgical findings for women with a positive and negative "sliding sign" during TVS are presented in Table 2.

Tables 3, 4 and 5 display the diagnostic performances of the TVS "sliding sign" alone; the direct visualization of rectal/rectosigmoid DE lesions using TVS alone; and the combination of TVS "sliding sign" and direct visualization of rectal/rectosigmoid DE lesions using TVS in the prediction of rectal and rectosigmoid DE at laparoscopy. 76/376 (20.2%) women had rectal/rectosigmoid DE confirmed at laparoscopy as per methods section. Of the 76 women with rectal/rectosigmoid DE, 60/76 (79%) had complete surgical excision and histopathological confirmation of endometriosis. For the remaining 16/76 (21.1%) women who did not undergo surgical excision of rectal/rectosigmoid DE at laparoscopy (due to the

absence of bowel symptoms), the rectal/rectosigmoid DE lesion was visualized at both TVS and laparoscopy in 13/16 patients (81.3%). Amongst those patients who did not undergo bowel excision of endometriosis, 11/16 also had POD obliteration at surgery (68.8). The presence of rectal/rectosigmoid DE and the need for bowel surgery were significantly associated with a negative TVS "sliding sign" (p-value<0.05).

The sensitivity of a negative "sliding sign" for the prediction of rectosigmoid DE was slightly superior when compared to rectal DE (77.4% vs. 72.4%). The co-occurrence of a negative "sliding sign" with the direct visualization of a rectal/rectosigmoid nodule had the highest specificity, as compared to direct visualization or "sliding sign" alone (95.3% vs 92.3% and 90.3%, respectively) (p-value<0.05), and the highest PPV (79.1% vs 74.2% and 65.9% respectively) (p-value<0.05).

There were 20/76 (26%) false negative cases, where the TVS "sliding sign" was positive, however rectal DE was detected at laparoscopy (p-value<0.05). The false positive rate was lower, as 30/300 (10%) women had a negative "sliding sign" and no DE at surgery. There were 10/76 (13%) false negative cases for direct visualization of rectal DE, where rectal DE nodules were detected during laparoscopy but not seen at TVS (p-value<0.05). The false positive rate for direct visualization of rectal DE with TVS was 8%. The false positive rate for a negative sliding sign (i.e. women with a negative sliding sign and no rectal DIE at laparoscopy) with TVS was 10%, whilst the combination of both associated a false positive rate of 5%.

## DISCUSSION

The current study found that direct visualization of rectal/rectosigmoid DE with TVS gave the highest accuracy (91.2%) and sensitivity (86.8%), and the combination of direct visualization and a negative "sliding sign" gave the highest specificity (95.3%) and PPV (79.1%), for the prediction of rectal/rectosigmoid DIE at laparoscopy (p-value<0.05). To the best of our knowledge, this is the first study which develops not only a comparison between a negative "sliding sign" and the direct visualization of rectal/rectosigmoid nodules during TVS in order to predict bowel disease during laparoscopy, but also with a combination of both ultrasound techniques. According to our results, the combination of direct visualization

of rectal/rectosigmoid nodules and a negative "sliding sign" is the best screening method to predict rectal/rectosigmoid DE at laparoscopy.

As has been demonstrated in previous studies, a negative TVS "sliding sign" alone was significantly associated with both rectal and rectosigmoid DE at laparoscopy. However, the sensitivity was lower compared to the recent study performed by Hudelist et al.[3] (73.7% vs. 85%) (p-value<0.05), and considerably lower when compared to the use of TVS to directly visualise rectal/rectosigmoid DE (73.7% vs. 86.8%) (p-value<0.05). It is therefore important to realize that rectal/rectosigmoid DE exists, and not infrequently, in the absence of utero-rectal adhesions. The current study demonstrated a false negative rate of 26% for the "sliding sign" and the prediction of rectal DE (i.e. positive "sliding sign" when rectal DE present at laparoscopy). Likewise, utero-rectal adhesions may form in the absence of rectal DE (Reid et al.[4], Leon et al.[5], Hudelist et al.[7]). Hence, a negative "sliding sign" may be observed in the absence of rectal DE, as was the case for 10% of women without rectal DE in the current study.

The finding that a negative TVS "sliding sign" is significantly associated with both rectal DE (Accuracy 93.1%, Sensitivity 85%, Specificity 96%, PPV 91%, NPV 94%) (Hudelist et al.[8]) and POD obliteration (Accuracy 93%, Sensitivity 83.3%, Specificity 97.1%, PPV 92.6%, NPV 93.2%)(Reid et al.[11]) is consistent, and is probably representative of the scale of disease. A rectal nodule may form initially, and as the severity of disease progresses, the rectal nodule may become adherent to the posterior uterus/cervix, causing POD obliteration. Although rectal/rectosigmoid DE is the most common cause for POD obliteration in women with endometriosis, it is important to also realize that POD obliteration can develop for reasons other than rectal DE. POD adhesions may also be caused by: superficial endometriosis located on the bowel serosa, ovarian surface and/or USL to the posterior uterus, and from scarring due to previous pelvic surgery. In addition, POD obliteration can occur when there is USL DE causing adhesions between the anterior rectum and USL/posterior cervix. Therefore, the TVS "sliding sign" should not be considered a specific ultrasound-based test for bowel endometriosis, but rather a test to predict utero-rectal adhesions (i.e. POD obliteration). Given the significant relationship between a negative "sliding sign" and rectal/rectosigmoid DE, indeed this ultrasound sign should be recognized as a sonographic hard marker for rectal/rectosigmoid DE.

Even in the presence of a positive "sliding sign", women with symptoms suspicious for posterior compartment DE (i.e. dyspareunia, dyschezia, hematochezia) should be referred to a specialized ultrasound unit to allow for a detailed TVS of the posterior compartment to determine whether DE is present. Encouragingly, a recent study on the learning curve for the prediction of rectal DE with TVS has shown that this skill is achievable after only ~ 40 TVS examinations for those experienced in gynaecological ultrasound. (Tammaa et al.[12]). Training programs which focus on developing skills such as the "sliding sign" and examination of the posterior compartment for DE should enable those performing gynaecological ultrasounds to accurately assess women with suspected endometriosis.

This study found that the combined approach (i.e. the TVS "sliding sign" and the direct visualization of the bowel with TVS) demonstrated the highest positive predictive value (79.1%) for the presence of bowel DE. Laparoscopic units can adopt either direct visualisation or combining both techniques depending upon what is clinically important to that individual unit, i.e. to predict rectal disease or avoid missing rectal disease. If a unit believes that clinically the most important outcome is to predict rectal DE at the time of surgery then they should choose the test with the highest LR(+), i.e. 14.94 (combined approach). Conversely, if it is more important to avoid missing rectal DE at the time of surgery, then they should choose the test with the lowest LR(-), i.e. 0.14 (direct visualization rectal DE technique).

There are some limitations of the present study that should be considered.

According to our results, direct visualization of rectal/rectosigmoid nodules had the highest sensitivity (87.0%), as compared to the sliding sign (73.7%) and the "combined approach" (69.7%) (p-value<0.05). In order to reduce the number of false positives, the combination of both techniques ("sliding sign" and direct visualization) appears to be the most accurate technique in a second stage, because it has the highest specificity as compared to the "sliding sign" and direct visualization alone (95.3% vs 90.3% and 92.3%, respectively) (p-value<0.05). However, we acknowledge that in order to be methodologically reliable, those two tests (first, direct visualization and second, combination of direct visualization and "sliding sign") should be performed sequentially and not simultaneously, as was the case in our study. Further studies need to be conducted in order to confirm this result.

Another limitation of the study is that those patients who were included in the study experienced chronic pelvic pain (hence, a high proportion of DE would be expected in our

study population) and therefore are a selected population. In addition, the sonologists did not perform the ultrasound techniques in isolation, and for example the presence of a negative "sliding sign" may have influenced the operator to assess the posterior compartment more thoroughly to seek out an underlying rectal DE lesion.

Lastly, the surgeons were not blinded to the TVS findings prior to surgery, and it may potentially bias the surgical appraisal. There were also 13 cases where a rectal DE nodule was visualized at TVS but was not resected at laparoscopy, as well as 11 cases that had a negative "sliding sign", however did not undergo complete dissection of the POD. This may have affected the diagnostic accuracy of the TVS "sliding sign" and direct visualization of bowel DE in this study, however, there were only 16/376 total cases (4.3%) women that did not undergo complete POD dissection and/or bowel DE excision.

## CONCLUSION

The TVS "sliding sign" alone does not perform as well direct visualization of rectal DE (+/- "sliding sign") for the prediction of rectal DE pre-operatively. A negative "sliding sign" should alert the sonographer/sonologist to the increased risk of bowel DE, and prompt a thorough assessment of the posterior compartment for sites of DE. In expert hands, the "combined technique" ("sliding sign" and direct evaluation of the rectum/rectosigmoid areas) appears to provide the most accurate assessment for the identification of rectal DE pre-operatively, but a sequential study amongst patients with rectal/rectosigmoid visible nodules should be conducted in order to confirm this result.

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**Table 1.** Presenting symptoms for women who underwent transvaginal sonography and laparoscopy (n=376).

| Symptom | Number missing | Number(%) |
|---|---|---|
| **Dysmenorrhea** | 0 | 241(64) |
| **Dyspareunia** | 0 | 166(44) |
| **Dyschezia** | 0 | 134(36) |
| **Hematochezia** | 0 | 29(8) |
| **Infertility** | 51 | 69(21) |

**Table 2**. Surgical positive findings for women with a positive and negative "sliding sign" at transvaginal sonography.

| **Disease location**[a] | **Total** **n=376** | **Positive "sliding sign"** **n (%)** | **Negative "sliding sign"** **n (%)** |
|---|---|---|---|
| **Rectal/Rectosigmoid DE** | 76 | 20(7%) | 56(66%) |
| **Rectovaginal septum/Vaginal DE** | 28 | 9(3%) | 19 (22%) |
| **Uterosacral ligament DE** | 66 | 42(15%) | 24(28%) |
| **Unilateral endometrioma** | 63 | 34(12%) | 29(34%) |
| **Bilateral endometrioma** | 31 | 8(3%) | 23(27%) |

DE= deep endometriosis

[a]there may have been more than one location affected with DE

**Table 3.** Diagnostic accuracy of the transvaginal ultrasound "sliding sign" alone for the prediction of deep infiltrating endometriosis (DE) of the rectum and rectosigmoid.

Rectal DE: defined as the presence of DE between the anal sphincter and the rectum at the level of the uterine fundus

| Surgical Findings | Accuracy | Sensitivity | Specificity | PPV | NPV | LR+ | LR- | p-value |
|---|---|---|---|---|---|---|---|---|
| **ULTRASOUND "SLIDING SIGN"** | | | | | | | | |
| **Rectal/rectosigmoid DE** | **87.0%** | **73.7% (62.3-83.1%)** | **90.3% (86.4-96.4%)** | **65.9%(54.8-75.8%)** | **93.1% (89.6-95.8%)** | **7.62 (5.3-11.1)** | **0.29(0.2-0.4)** | **<0.05** |
| **Rectosigmoid** | **81.9%** | **77.4% (58.9/90.4%)** | **82.3%(77.9-86.2%)** | **28.2% (19-39%)** | **97.6% (95.1-99%)** | **4.38 (3.3-5.9)** | **0.27(0.1-0.5)** | **<0.05** |
| **Rectum** | **84.3%** | **72.4% (59.1/83.3%)** | **86.5%(82.2-90%)** | **49.4% (38.4-60.5%)** | **94.5%(91.2-96.8%)** | **5.36 (3.9-7.4)** | **0.32(0.2-0.5)** | **<0.05** |

Rectosigmoid DE: defined as the presence of DE at the level of the uterine fundus

Values in parentheses are 95% CIs. * $P < 0.05$ considered statistically significant (Fisher's exact test). DE, deep endometriosis; LR +, positive likelihood ratio, LR–, negative likelihood ratio; NPV, negative predictive value; POD, pouch of Douglas; PPV, positive predictive value.

**Table 4.** Diagnostic accuracy of the transvaginal ultrasound "direct visualization" for the prediction of deep infiltrating endometriosis (DE) of the rectum and rectosigmoid.

| Surgical Findings | Accuracy | Sensitivity | Specificity | PPV | NPV | LR+ | LR- | p-value |
|---|---|---|---|---|---|---|---|---|
| **TRANSVAGINAL DIRECT VISUALIZATION** | | | | | | | | |
| **Rectal/rectosigmoid DIE** | **91.2%** | **86.8% (77.1-93.5%)** | **92.3%(88.7-95.1%)** | **74.2%(63.8-82.9%)** | **96.5%(93.7-98.3%)** | **11.3 (7.6-16.9)** | **0.14 (0.1-0.3)** | **<0.05** |
| **Rectosigmoid** | **91.4%** | **71.0% (52-85.8%)** | **96.2%(93.6-98%)** | **62.9%(44.9-78.5%)** | **97.4%(95%-98.8%)** | **18.8 (10.6-33.6)** | **0.30(0.2-0.5)** | **<0.05** |
| **Rectum** | **89.6%** | **72.4% (59.1-83.3%)** | **92.8%(89.3-95.4%)** | **64.6% (51.8-76.1%)** | **94.9% (91.8-97%)** | **10.0 (6.6-15.3)** | **0.30 (0.2-0.5)** | **<0.05** |

Rectal DE: defined as the presence of DE between the anal sphincter and the rectum at the level of the uterine fundus

Rectosigmoid DE: defined as the presence of DE at the level of the uterine fundus

Values in parentheses are 95% CIs. * $P < 0.05$ considered statistically significant (Fisher's exact test). DE, deep endometriosis; LR +, positive likelihood ratio, LR–, negative likelihood ratio; NPV, negative predictive value; POD, pouch of Douglas; PPV, positive predictive value.

**Table 5.** Diagnostic accuracy of the transvaginal ultrasound "combined approach" (negative "sliding sign" and the direct visualization of rectal/rectosigmoid nodules) for the prediction of deep infiltrating (DE) of the rectum and rectosigmoid.

| Surgical Findings | Accuracy | Sensitivity | Specificity | PPV | NPV | LR+ | LR- | p-value |
|---|---|---|---|---|---|---|---|---|
| **"COMBINED APPROACH" (NEGATIVE SLIDING SIGN AND DIRECT VISUALIZATION)** | | | | | | | | |
| | **90.2%** | **69.7%(58.1-79.8%)** | **95.3%(92.3-97.4%)** | **79.1% (67.4-88.1%)** | **92.6%(89-95.2%)** | **14.94(8.8-25.5)** | **0.32(0.2-0.5)** | **<0.05** |
| **Rectal/rectosigmoid DIE** | | | | | | | | |
| **Rectosigmoid** | **93.6%** | **54.8%(36-72.7%)** | **97.1%(94.7-98.6%)** | **63.0%(42.4-80.6%)** | **96.0%(93.4-97.8%)** | **18.92(9.5-37.7)** | **0.47(0.3-0.7)** | **<0.05** |
| **Rectum** | **89.6%** | **58.6%(44.9-71.4%)** | **95.3%(92.3-97.3%)** | **69.4%(54.6-81.7%)** | **92.7%(89.3-95.2%)** | **12.43(7.3-21.3)** | **0.43(0.3-0.6)** | **<0.05** |

Rectal DE: defined as the presence of DE between the anal sphincter and the rectum at the level of the uterine fundus

Rectosigmoid DE: defined as the presence of DE at the level of the uterine fundus

Values in parentheses are 95% CIs. * P < 0.05 considered statistically significant (Fisher's exact test). DE, deep endometriosis; LR +, positive likelihood ratio, LR–, negative likelihood ratio; NPV, negative predictive value; POD, pouch of Douglas; PPV, positive predictive value.