Analysis of the Diagnostic Value of Transrectal Ultrasonography for Rectal Submucosal Lesions

Guangchen Zhang, MM; Lisha Cui, MM; Xiaoyu Wang, PhD; Yinzhu Chu, MD; Changjun Wu, MD

ABSTRACT
Objective • This study aims to investigate the diagnostic value of transrectal ultrasonography for rectal submucosal lesions.
Methods • A retrospective analysis was conducted on 132 patients with rectal submucosal lesions admitted to our hospital from June 2018 to May 2022. All patients underwent colonoscopy, miniprobe endoscopic ultrasonography, and transrectal ultrasonography before surgery, obtaining definitive pathological results. The lesions displayed smooth morphological eminence of the mucosa under a colonoscope. Among the patients, there were 76 males and 56 females, with an average age of 50.6 years. Using pathology as the gold standard, the diagnostic accuracy of transrectal ultrasonography and miniprobe endoscopic ultrasonography for rectal submucosal lesions was calculated, and the difference between the two was compared using the chi-square ($\chi^2$) test.
Results • The overall diagnostic accuracy of transrectal ultrasonography and miniprobe endoscopic ultrasonography for all rectal submucosal lesions was 95.5% and 74.2%, respectively. It was observed that transrectal ultrasonography was superior to miniprobe endoscopic ultrasonography, and the difference was statistically significant ($\chi^2 = 25.48, P < .05$).
Conclusions • Transrectal ultrasonography demonstrates high diagnostic value for rectal submucosal lesions and may serve as the preferred choice for their examination. (Altern Ther Health Med. [E-pub ahead of print.])

INTRODUCTION
Rectal submucosal lesions typically refer to morphological eminences formed by the pushing of the mucosa due to lesions in the intestinal wall beneath the mucosal layer or compression against the intestinal wall caused by lesions outside the intestine. These lesions are often discovered during colonoscopy and digital rectal examination. Previous studies have primarily focused on using transrectal ultrasonography (TRUS) for diagnosing anal fistula, perianal abscess, rectal cancer, and prostate diseases. However, there is a lack of research regarding the application of TRUS in diagnosing rectal submucosal lesions. In this study, we employed TRUS for diagnosing rectal submucosal lesions and compared it with miniprobe endoscopic ultrasonography (mEUS) to explore the diagnostic value of TRUS for such lesions.

MATERIALS AND METHODS
Study Design
This study employed a retrospective analysis design to investigate the diagnostic value of TRUS for rectal submucosal lesions. Data from 132 patients diagnosed with rectal submucosal lesions between June 2018 and May 2022 were included in the analysis.

Subjects
The selected subjects diagnosed with rectal submucosal lesions by colonoscopy at our hospital were retrospectively analyzed. All patients underwent colonoscopy, miniprobe endoscopic ultrasonography, and transrectal ultrasonography to obtain definitive pathological results. The lesions located within 12 cm from the anal margin displayed a smooth morphological eminence of the mucosa during colonoscopy. The study population consisted of 76 males and 56 females, ranging in age from 18 to 72 years, with an average age of 50.6 years. Ethical approval for this study was obtained from the ethics committee.
Anechoic, roundish, clear boundary and thin wall, and enhanced posterior echo. Muscularis Cystic/solid mixed echo, irregular shape, unclear boundary, and fistula are seen in most cases. The layers of the intestinal wall are clear, and the main mass is located outside the intestine. When Submucosa and Hypoechoic, roundish, clear boundary, rich blood supply. Submucosa Hypoechoic, irregular shape, unclear boundary, rich marginal blood supply, and visible fistula. Stomach Submucosa Hypoechoic, roundish, clear boundary, rich blood supply. Submucosa and Muscularis Often found on the anterior rectum wall, hypoechoic, long strip shape, unclear boundary, and poor blood supply. External Compression Eminence Parenteral The layers of the intestinal wall are clear, and the main mass is located outside the intestine. When the intestinal wall is invaded, the layers of the intestinal wall change from inside to outside.

Table 1. Ultrasonic Features of Rectal Eminence Lesions

<table>
<thead>
<tr>
<th>Pathology</th>
<th>Cases</th>
<th>Origin/Location</th>
<th>Ultrasonic Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyst</td>
<td>5</td>
<td>Submucosa</td>
<td>Anechoic, roundish, clear boundary and thin wall, and enhanced posterior echo.</td>
</tr>
<tr>
<td>Neuroendocrine Tumor</td>
<td>19</td>
<td>Submucosa</td>
<td>Hypoechoic, roundish, clear boundary, and rich blood supply.</td>
</tr>
<tr>
<td>Submucosal Abscess</td>
<td>18</td>
<td>Submucosa</td>
<td>Cystic/solid mixed echo, irregular shape, unclear boundary, and fistula are seen</td>
</tr>
<tr>
<td>Internal Blind Fistula</td>
<td>27</td>
<td>Submucosa or muscularis</td>
<td>Hypoechoic, irregular shape, unclear boundary, rich marginal blood supply, and visible fistula.</td>
</tr>
<tr>
<td>Stromal Tumor</td>
<td>21</td>
<td>Muscularis</td>
<td>Hypoechoic, roundish, clear boundary, rich blood supply, irregular shape in large</td>
</tr>
<tr>
<td>Endometriosis</td>
<td>16</td>
<td>Submucosa and muscularis</td>
<td>Often found on the anterior rectum wall, hypoechoic, long strip shape, unclear</td>
</tr>
<tr>
<td>External Compression</td>
<td>26</td>
<td>Parenteral</td>
<td>Eminence</td>
</tr>
<tr>
<td>Total</td>
<td>132</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Instruments Used

TRUS was performed using MyLab 90 and MyLab Twice color Doppler ultrasound diagnostic instruments (Esaote S.p.A., Sifredi, Genova, Italy). The TRUS examinations utilized a TRT33 transrectal biplane probe with a linear array frequency of 4-13 MHz and a convex array frequency of 3-9 MHz, and an EC123 head scanning probe (convex array frequency: 3-5 MHz). For miniprobe endoscopic ultrasonography (mEUS), an SP702 mainframe (FUJIFILM Corporation, Nishiazabu, Tokyo, Japan) was utilized, along with P2625 and P2615 miniprobes with a frequency range of 15-25 MHz.

Examination Methods

Patients with contraindications for TRUS were excluded from the study, including those with (1) anal canal and rectal stenosis; (2) foreign bodies present in the rectum or sigmoid colon; (3) severe cardiopulmonary diseases; (4) pregnancy and (5) inability to cooperate with the examination. Prior to the procedure, an enema was administered to ensure stool evacuation. Additionally, moderate bladder filling was performed to aid in lesion localization.

During the examination, the patient was positioned in a left lateral decubitus position with both legs flexed. The TRT33 probe was used to scan the lesions. The probe was properly coated with couplant, covered with a disposable latex sleeve to ensure a snug fit and removal of air, and inserted slowly into the rectum along the anorectal angle. Initially, a longitudinal scan was conducted using a linear array mode, rotating the probe 360° from shallow to deep until the lesion was identified. Subsequently, a horizontal scan was performed using a convex array mode. The location, origin, size, shape, boundary, internal echo, the blood supply of the lesion, and the presence or absence of enlarged lymph nodes surrounding the lesion were comprehensively assessed by combining the linear array and convex array modes. Data were recorded, and images were saved. In cases where the lesion was located in a higher position and could not be detected by the TRT33 probe, the EC123 probe was employed for an upward scan.

Table 1. Pathological Results and Ultrasonic Imaging Characteristics

The 132 cases of rectal submucosal lesions yielded the following pathological results: Submucosal cysts were identified in 5 cases (Figure 1), neuroendocrine tumors in 19 cases (Figure 2), submucosal abscesses in 18 cases (Figure 3), internal blind fistulas in 27 cases (Figure 4), stromal tumors in 21 cases (Figure 5), rectal endometriosis in 16 cases (Figure 6), and external compression eminences in 26 cases (Figure 7-12). See Table 1 for the ultrasonic imaging characteristics of all cases.

Within the 26 cases of external compression lesions, suprarelevator abscesses were observed in 8 cases, and a solitary fibrous tumor in the pelvic region was detected in 1 case located in the suprarelevator space. Furthermore, 10 cases of presacral tumors were found in the presacral space, and these included 5 cystic lesions (including 4 cases of epidermoid cysts and 1 case of teratoma), 3 solid lesions (including 1 case of ganglieneuroma, 1 case of chordoma, and 1 case of liposarcoma), as well as 2 cystic-solid lesions (including 1 case of schwannoma and 1 case of neurofibroma). Additionally, adjacent organ origins were noted, including 2 cases of prostate cancer, 2 cases of cervical cancer, 1 case of endometrial cancer, and 2 cases of ovarian tumors, see Table 1.

Statistical analysis

Statistical analysis was performed using SAS 9.4 software (Statistical Analysis System Institute Incorporated, Kerrv, North Carolina, USA). Due to the limited penetration capacity of mEUS, confirmation of external compression for external compression lesions was deemed sufficient, and further determination of their origin and nature was unnecessary. Using pathology as the gold standard, the diagnostic accuracy of both TRUS and mEUS for each type of rectal submucosal lesion was calculated, and the differences were compared using the chi-square test ($\chi^2$ test). Furthermore, the overall diagnostic accuracy of TRUS and mEUS for all rectal submucosal lesions was calculated, and the differences were compared using the paired chi-square test ($\chi^2$ tests). A significance level of $P<.05$ was considered statistically significant.
**Figure 1.** Transrectal ultrasound images of the submucosal cyst. (A) The lesion is located in the submucosa of the intestinal wall, presenting as a roundish cystic anechoic image with a clear boundary, thin wall, and enhanced posterior echo; (B) No blood flow signal was found in the lesion.

**Figure 2.** Transrectal ultrasound images of neuroendocrine tumor. (A) The lesion is located in the submucosa of the intestinal wall, presenting as a roundish hypoechoic image with a clear boundary; (B) Rich blood flow in the lesion.

**Figure 3.** Transrectal ultrasound images of a submucosal abscess. (A) The lesion is located in the submucosa of the intestinal wall, showing fluid-solid mixed echo, with an irregular shape, unclear boundary, fluid echo in the center, and poor acoustic transmission; (B) Rich blood flow at the edge of the lesion.

**Figure 4.** Transrectal ultrasound images of internal blind fistula. (A) The lesion is located in the submucosa and muscularis of the intestinal wall, presenting as a hypoechoic image with an irregular shape and unclear boundary, and the fistula towards the dentate line of the anal canal at the edge of the lesion (shown by red arrow); (B) Rich blood flow at the edge of the lesion.

**Figure 5.** Transrectal ultrasound images of the stromal tumor. (A) The lesion is connected to the muscularis of the intestinal wall, presenting as a roundish hypoechoic image, with clear boundary; (B) Rich blood flow in the lesion.

**Figure 6.** Transrectal ultrasound images of rectal endometriosis. (A) The lesion is located in the submucosa and muscularis of the intestinal wall, presenting as a hypoechoic image, with an irregular shape and ill-defined boundary; (B) Poor blood flow in the lesion.

**Figure 7.** Transrectal ultrasound images of a pelvic solitary fibrous tumor. (A) The lesion is located in the pelvirectal space, presenting as a hypoechoic image, with scattered small cystic echo inside and clear boundary, compressing rectum; (B) Rich blood flow in the lesion.

**Figure 8.** Transrectal ultrasound images of presacral liposarcoma. (A) The lesion is located in the presacral space, presenting as a slightly hyperechoic image, with non-uniform internal echo and clear boundary, compressing the rectum; (B) Rich blood flow in the lesion.
Comparison between TRUS and mEUS

The diagnostic accuracy of TRUS and mEUS for rectal submucosal lesions were compared, and the results are presented in Table 2. Specifically, the diagnostic accuracy of TRUS and mEUS for cysts, neuroendocrine tumor, stromal tumor, and external compression eminence was 100% vs. 100%, 89.5% vs. 94.7%, 95.2% vs. 85.7%, and 100% vs. 100%, respectively. No statistically significant differences were observed between the two methods (P > .05).

For submucosal abscess, internal blind fistula, and endometriosis, the diagnostic accuracy of TRUS and mEUS was 94.4% vs. 72.2%, 96.3% vs. 25.9%, and 93.8% vs. 62.5%, respectively. It was evident that TRUS outperformed mEUS, with statistically significant differences (P < .05).

Furthermore, the overall diagnostic accuracy of TRUS (95.5%) for all rectal submucosal lesions was significantly higher than that of mEUS (74.2%), with a statistically significant difference (P < .05).

The diagnostic accuracy of TRUS and mEUS for external compression lesions was found to be 100% for both methods. Furthermore, TRUS demonstrated the ability to provide detailed information regarding the origin, size, shape, and blood supply of the lesions. This valuable information contributes to enhanced qualitative diagnosis and treatment planning, thus establishing the superiority of TRUS over mEUS in this regard.

DISCUSSION

Rectal submucosal lesions, a prevalent condition in the lower gastrointestinal tract, exhibit morphological prominence; however, the pathological results can vary significantly. Consequently, an accurate diagnosis holds paramount importance in selecting an appropriate treatment plan and assessing prognosis. Although colonoscopy can identify the prominence, determining the origin and nature of the lesions remains challenging. While colonoscopic
biopsy demonstrates high diagnostic accuracy for mucosal lesions, its limited sampling depth hampers the detection of true submucosal lesions.1

mEUS, a diagnostic technique utilizing ultrasonic imaging with a miniprobe positioned at the tip of an endoscope, was employed in this study. The circular scanning probe of mEUS enabled clear visualization of the layers of the intestinal wall. This technique provided insights into the origin of rectal submucosal lesions and offered valuable information regarding their shape, extent, margins, and internal echoes. These features of mEUS contributed significantly to the qualitative diagnosis of rectal submucosal lesions.7,8

TRUS, an alternative ultrasonic imaging technique, is performed by inserting a cylindrical intracavitary probe into the rectum. This study highlights the advantages of TRUS over miniprobe endoscopic ultrasonography mEUS in evaluating rectal submucosal lesions. TRUS offers several key benefits: (1) TRUS probes are equipped with a low frequency and strong penetration capacity, enabling them to effectively visualize the complete shape of large lesions and accurately identify the origin of external compression lesions. This capability proves invaluable in providing a comprehensive assessment of the lesions; (2) TRUS employs both longitudinal and horizontal imaging, resulting in a larger imaging range that allows for the display of finer details and facilitates the identification of lesion origins with enhanced precision; (3) TRUS incorporates color Doppler flow imaging, which provides crucial information on the blood supply of lesions, aiding in their characterization; (4) TRUS has less stringent requirements for intestinal preparation, eliminating the need for oral bowel-cleaning drugs and allowing for a simpler transanal enema instead. Its streamlined preparation process is advantageous for patients; and (5) TRUS stands out for its simplicity, convenience, cost-effectiveness, and strong repeatability, making it an accessible and reliable imaging modality for evaluating rectal submucosal lesions. TRUS demonstrates distinct advantages over mEUS, offering an attractive alternative for clinicians in clinical practice.

Both TRUS and mEUS demonstrate a high diagnostic coincidence rate for cysts and carcinoid tumors, with no statistically significant differences observed. Similarly, the diagnostic accuracy of both TRUS and mEUS for small stromal tumors (diameter ≤3 cm) is high, without any significant differences noted. However, when it comes to large stromal tumors (diameter >3 cm), TRUS has a clear advantage over mEUS.9 In the present study, two cases of stromal tumors with diameters exceeding 5 cm were correctly diagnosed using TRUS. Conversely, due to its limited penetration capacity, mEUS failed to provide a comprehensive visualization of lesion shape and origin, leading to misdiagnosis; this finding is consistent with previous literature reports.5

This study provides evidence to support the superiority of TRUS over mEUS in terms of diagnostic accuracy for submucosal abscess, internal blind fistula, and rectal endometriosis. The enhanced diagnostic performance of TRUS can be attributed to its biplane imaging capability, wider imaging range, stronger penetration capacity, and the inclusion of color Doppler flow imaging, which collectively contribute to improved visualization and characterization of lesions.

In TRUS, submucosal abscesses are characterized by mixed echogenic masses with tenderness within the submucosa and muscularis layers. The center of the abscess typically shows fluid echo (pus), while the non-fluid part at the edge contains inflammatory tissues, exhibiting abundant blood supply. Furthermore, the presence of a fistula along the submucosa extending to the dentate line of the anal canal is often observed at the edge of the abscess. However, mEUS faces challenges in displaying the fistula due to its limited ability to perform longitudinal imaging along the long axis of the intestinal canal. On the other hand, internal blind fistulas consist of an internal opening and a fistula without an external opening. The blind end of the fistula typically contains inflammatory tissues predominantly located in the rectal submucosa. Ultrasonically, these inflammatory tissues appear as hypoechoic nodules within the submucosa, which can be easily misdiagnosed as neuroendocrine tumors when using mEUS.

In TRUS, internal blind fistulas are characterized by hypoechoic masses or nodules within the submucosa layer, accompanied by an abundant blood supply. Additionally, the presence of a fistula along the submucosa extending to the dentate line of the anal canal can be observed at the edge. Fistulas serves as one of the characteristic manifestations in the diagnosis of submucosal abscesses and internal blind fistulas. Combining TRUS with digital rectal examination can enhance the detection rate of fistulas.

Rectal endometriosis primarily occurs in the submucosa to the serosa layer of the anterior rectal wall. Ultrasonically, it appears as irregular long-strip-shaped hypoechoic areas with unclear boundaries. The long axis of these areas is parallel to that of the intestinal canal. Rectal endometriosis is associated with poor blood supply and is often accompanied by ovarian chocolate cysts and adenomyosis. When detecting rectal endometriosis, TRUS can also assess the presence or absence of ectopic lesions in the uterus and ovary simultaneously, thereby improving diagnostic accuracy.10-11 Furthermore, by applying pressure to the affected intestinal canal, TRUS enables dynamic observation of the relative movement between the intestinal canal and the uterus. It facilitates the determination of the presence or absence of adhesion between the lesion and the uterus.12

The ultrasound characteristics of external compression lesions include a clear intestinal wall and the protrusion of the lesions into the intestinal cavity due to the compression of extraintestinal structures against the intestinal wall. However, due to its limited penetration capacity and the large volume of external compression lesions, mEUS is unable to accurately display the origin and complete shape of the lesions. It can only confirm the presence of external compression. On the other hand, TRUS not only provides a comprehensive view of the lesion’s shape but also identifies the source of the lesion. Additionally, TRUS evaluates the nature of the lesions based
on their cystic or solid features and blood supply, thus offering valuable imaging information for clinical practice.

In this study, TRUS successfully diagnosed 8 cases of pelvirectal abscess, 2 cases of prostate cancer, 2 cases of cervical cancer, and 1 case of endometrial cancer. Furthermore, TRUS accurately identified 2 cases of ovarian tumors as ovarian hypervascular masses, with the pathological results confirming a Brenner tumor and mucinous adenocarcinoma. Presacral tumors exhibit diverse pathological types due to the complex tissue structure of the presacral space. TRUS demonstrates a superior diagnostic value for presacral epidermoid cysts and teratomas, achieving a diagnostic coincidence rate of 100%. However, TRUS cannot accurately diagnose solid or cystic-solid presacral tumors, including liposarcoma, ganglioneuroma, chordoma, schwannoma, and neurofibroma. At best, it suggests the presence of solid or cystic-solid space-occupying lesions within the presacral space. Therefore, further experience and case studies are needed to improve diagnostic accuracy in these cases.

Solitary fibrous tumors are rare spindle-shaped mesenchymal tumors, particularly in the pelvic cavity. In this study, a solitary fibrous tumor located in the pelvirectal space appeared as large roundish hypoechoic masses with distinct boundaries. The tumor exhibited small focal cystic areas of varying sizes dispersed throughout, resulting in a spongiform appearance of the entire tumor, consistent with previous literature reports and demonstrating unique characteristics.11

TRUS has the following deficiencies: (1) It may cause discomfort to patients during the examination, which can affect their experience and cooperation; (2) The range of probing is limited, typically extending from the anal margin to a distance of 12-15 cm. This restricted reach may hinder the assessment of lesions located beyond this range; (3) Gas in the intestinal tract can interfere with the imaging quality of TRUS. To minimize this interference, the probe must be positioned closely against the intestinal wall, requiring skilled operation techniques; (4) TRUS may have reduced sensitivity in detecting small lesions, potentially leading to missed diagnoses.3 This study identified one case of a small carcinoid lesion (approximately 0.4×0.3 cm) that was not detected by TRUS.

**Study Limitations**

The present study has several limitations that should be acknowledged. The small sample size, particularly for presacral tumors, may affect the generalizability and statistical power of the findings, warranting caution in interpreting the results. Further studies with larger sample sizes are needed to validate the findings and draw more robust conclusions. Additionally, the study’s focus on a specific population or region may limit the generalizability of the findings to broader contexts, as unique characteristics of the studied population may influence the results. The study design, being retrospective, introduces inherent limitations such as selection bias and incomplete information. Prospective studies with well-defined protocols and larger sample sizes would provide more rigorous evidence. Moreover, the study primarily assessed diagnostic accuracy and imaging capabilities, neglecting other relevant factors like patient outcomes and long-term follow-up. Future research should incorporate comprehensive outcome measures to better understand TRUS in managing rectal submucosal lesions.

**CONCLUSION**

In conclusion, this study highlights the high diagnostic value of TRUS for rectal submucosal lesions. The findings suggest that TRUS can be considered the first-choice examination method for these diseases. Its ability to display the origin, whole shape, and characteristics of lesions, as well as its bipline imaging, large imaging range, strong penetration capacity, and color Doppler flow imaging function, contribute to its superiority over mEUS. However, it is important to acknowledge the limitations of this study, including the small sample size and the need for further research with larger cohorts and comprehensive outcome measures. Overall, TRUS shows promise as an effective tool for diagnosing rectal submucosal lesions.

**CONFLICT OF INTEREST**

The authors have no potential conflicts of interest to report relevant to this article.

**AUTHORS’ CONTRIBUTION**

GZ and CW designed the study and performed the experiments; LC and XW collected the data; LC, XM, and YC analyzed the data; and GZ and CW prepared the manuscript. All authors read and approved the final manuscript.

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**REFERENCES**


