

Preoperative endoscopic ultrasonography wall-layer stratification and bowel surgical management in rectosigmoid deep infiltrating endometriosis: a single-center retrospective study

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Abstract

Background

Rectosigmoid deep infiltrating endometriosis (DIE) is a complex condition that may require a range of surgical treatments, from rectal shaving to disc excision or segmental bowel resection. Because the choice of procedure depends partly on the depth and extent of bowel-wall involvement, accurate preoperative assessment is crucial for surgical planning. Endoscopic ultrasonography (EUS) can visualize the individual layers of the rectosigmoid wall and may provide useful information regarding the extent of bowel infiltration. However, whether EUS wall-layer grading is associated with the type of subsequent bowel surgery remains uncertain. This study aimed to evaluate this association in patients with rectosigmoid DIE.

Methods

We retrospectively studied 25 patients with DIE who underwent lower gastrointestinal EUS before surgery at one center between 2018 and 2024. EUS wall-layer involvement was graded 0–3 by the deepest suspected layer, and bowel surgical management from no therapeutic bowel-wall treatment to segmental resection. The primary analysis used Spearman correlation; perioperative and paired EUS–magnetic resonance imaging (MRI) analyses were exploratory.

Results

EUS grades 0–3 were assigned to 5, 4, 11, and 5 patients, and surgical-management grades 0–3 occurred in 8, 3, 4, and 10. Higher EUS grade was associated with more extensive bowel surgical management (Spearman's $\rho = 0.77$, $P < 0.001$). Segmental resection occurred in 10/16 patients (62.5%) with EUS grades 2–3 and 0/9 with grades 0–1 (Fisher's exact $P = 0.003$). Grades 2–3 were associated with greater blood loss, longer operative time, and longer hospital stay (all $P \leq 0.032$). Among 21 operative-positive paired examinations, EUS identified involvement in 17 (81.0%) and MRI in 11 (52.4%; exact McNemar $P = 0.109$).

Conclusion

Higher preoperative EUS wall-layer grades were associated with more extensive bowel surgical management in rectosigmoid DIE. EUS may complement counselling and multidisciplinary preparation for possible bowel intervention, but should not independently indicate segmental resection.

Clinical trial number:

not applicable

Introduction

Deep infiltrating endometriosis (DIE) is characterized by endometriotic lesions infiltrating beneath the peritoneal surface and may involve the rectosigmoid bowel [1]. Rectosigmoid DIE may be associated with dyschezia, cyclic rectal bleeding, bowel dysfunction, and pelvic pain, often in the setting of coexisting gynecologic symptoms such as dysmenorrhea and dyspareunia. Bowel management ranges from bowel-sparing lesion excision and repair to discoid resection and segmental bowel resection [2, 3]. Choosing among these approaches requires a clear preoperative understanding of lesion location, depth, and extent so that patients can be counselled appropriately and the operative team can prepare for the possible need for bowel intervention.

Magnetic resonance imaging (MRI) provides a broad assessment of pelvic anatomy and the relationship between endometriotic lesions and adjacent organs [4–5, 14]. Lower gastrointestinal endoscopic ultrasonography (EUS), in contrast, can provide detailed visualization of rectosigmoid wall layers [6–7]. Previous studies have principally examined imaging performance using histopathology or surgical findings as the reference standards [8, 9], and MRI-derived features and scoring systems have been developed to guide operative planning [10, 11]. A related clinical question is whether the depth of bowel-wall involvement described on preoperative EUS is associated with the bowel surgical management ultimately undertaken in routine practice.

We therefore evaluated the association between preoperative EUS wall-layer grade and actual bowel surgical-management grade in patients with rectosigmoid DIE. Secondary exploratory analyses examined perioperative outcomes according to EUS grade and paired EUS–MRI findings in patients who underwent both examinations.

Materials and methods

Study design and participants

We conducted a single-center retrospective study at Xijing Hospital, Air Force Medical University. Medical records of patients treated in the Department of Gynecology between August 2018 and December 2024 were reviewed. Preoperative lower gastrointestinal EUS was requested at the discretion of the treating team when rectosigmoid involvement was suspected on clinical assessment or other preoperative imaging. The analytic cohort comprised 25 patients with pelvic DIE who underwent preoperative lower gastrointestinal EUS followed by surgery at our institution during the study period. Patients were eligible if pelvic DIE was confirmed at surgery and by postoperative pathology, bowel-wall assessment had been documented on EUS, and operative records described bowel involvement and its management.

All included patients had surgically treated pelvic DIE with postoperative histopathologic confirmation of endometriosis. Histopathologic confirmation of bowel-wall involvement was available only when bowel-wall tissue was resected; in patients managed without bowel-wall resection, bowel involvement was defined according to operative findings. No patients were excluded from the identified analytic cohort because of incomplete operative or pathology records, and none had colorectal cancer, inflammatory bowel disease, or another bowel disease likely to affect bowel-wall assessment. This was a retrospective surgical cohort rather than a consecutive diagnostic cohort of all patients referred for lower gastrointestinal EUS. Patients with DIE who underwent surgery without preoperative EUS were not included, and the number of patients who underwent EUS without subsequent surgery or who underwent surgery elsewhere could not be reconstructed from the retrospective data source. Reporting was planned in line with the STROBE recommendations.

The study was conducted in accordance with the Declaration of Helsinki. The study protocol was reviewed by the Ethics Committee of the First Affiliated Hospital of the Air Force Medical University (approval number: KY20252314-C-1). The requirement for informed consent was waived because of the retrospective design.

EUS examination

Lower gastrointestinal EUS was performed after bowel preparation with a polyethylene glycol enema and under intravenous anesthesia, using Olympus echoendoscopes (Olympus Medical Systems, Tokyo, Japan). Each examination was performed jointly by at least two experienced endoscopists, and the report was issued after consensus was reached. The specific echoendoscope models and frequencies were not uniformly recorded in the examination reports.

EUS and surgical classifications

A pragmatic EUS wall-layer classification was used to categorize the deepest suspected level of bowel-wall involvement documented in the original EUS reports. EUS findings were classified as grade 0, no definite bowel-wall involvement; grade 1, serosal, adventitial, or surrounding-tissue involvement without muscularis involvement; grade 2, muscularis involvement; and grade 3, submucosal or mucosal involvement. EUS wall-layer grades were assigned retrospectively by the investigator who collected the case data from the descriptive findings in the original EUS reports; stored images and videos were not re-reviewed. Grades were assigned from EUS reports before linkage to surgical data, without knowledge of surgical-management grade or other operative outcomes.

Surgical management was classified according to the actual bowel-wall intervention documented in the operative record: grade 0, bowel-sparing management without therapeutic bowel-wall treatment (no bowel-wall excision, shaving, incision, or suturing; adhesiolysis or mobilization alone was allowed); grade 1, bowel-wall treatment without resection (e.g., shaving, serosal excision, trimming, or

reinforcement/repair); grade 2, discoid, disc, or local bowel-wall resection with repair; and grade 3, segmental bowel resection with restoration of bowel continuity. This ordinal scale quantifies the depth and aggressiveness of the bowel-wall procedure, rather than total surgical complexity, which may also be affected by extra-bowel disease and concomitant procedures. Surgical-management grades were assigned retrospectively from operative records by at least two senior gynecologic surgeons (professor level), including the operating surgeon, according to the bowel management actually performed.

The two ordinal systems represent different clinical constructs: EUS grade reflects the preoperative imaging-based depth of suspected bowel-wall involvement, whereas surgical-management grade reflects the bowel procedure actually performed. Accordingly, the primary objective was to evaluate their association rather than agreement against an independent diagnostic reference standard.

Surgical management and decision-making

Surgical management was determined by the treating gynecologic surgical team using preoperative assessment and intraoperative findings, with intraoperative on-table consultation by colorectal surgeons when bowel involvement was encountered. The operating team had access to preoperative EUS reports and other available clinical and imaging information, including MRI when available. EUS was one component of the clinical decision-making process and was not the sole determinant of the surgical procedure. The observed relationship between EUS grade and surgical management therefore reflects the clinical pathway in which EUS contributes to preoperative planning, rather than an independent diagnostic-validation design. Perioperative outcomes were examined as secondary clinical outcomes that may reflect disease extent, the procedure performed, and other perioperative factors.

Perioperative variables

The following variables were collected: age, body mass index, symptoms, gynecologic comorbidities, operative blood loss, operative time, hospital stay, and the interval from EUS to surgery. Operative time was defined as the interval from the start to completion of surgery in the operative record, and estimated blood loss was abstracted from the operative record. Hospital stay was defined as total in-hospital care in days, including preoperative and postoperative periods; patients typically underwent surgery on the second day after admission. The EUS examination date was coded as day 0, and the surgery-date variable represents the interval in days from EUS to surgery.

Paired MRI–EUS analysis

MRI was performed in 21 of the 25 patients; the remaining four did not undergo MRI as part of their preoperative assessment. MRI examinations used 3.0-T scanners with uterus- and adnexa-focused pelvic protocols, consisting predominantly of unenhanced T2-weighted imaging, with contrast-enhanced

sequences in some patients. MRI findings were obtained from the official reports issued by specialist radiologists at the time of preoperative assessment, without central image rereading.

For the paired subgroup, operative exploration served as the reference for rectosigmoid involvement: rectal, rectosigmoid, or sigmoid involvement documented during surgery, including direct bowel-wall involvement or dense adhesions involving the bowel, was classified as positive. EUS positivity was defined as grade ≥ 1 , and MRI positivity as a radiology report indicating rectal, rectosigmoid, or sigmoid involvement. Because all 21 patients met this operative reference definition, the paired analysis compared the proportion in whom each modality identified involvement; it could not estimate specificity, negative predictive value, or overall diagnostic accuracy. The operative definition included both direct bowel-wall involvement and dense adhesions and was therefore broader than the EUS wall-layer target.

Statistical analysis

The primary analysis assessed the association between ordinal EUS grade and ordinal surgical-management grade using Spearman rank correlation. Continuous variables are presented as medians with interquartile ranges because of the small sample size and non-normal distributions, and categorical variables as counts and percentages. Between-group comparisons of perioperative variables used the Mann–Whitney U test.

For exploratory grouped analyses, EUS grades were categorized as 0–1 and 2–3. The association between this grouping and segmental resection was assessed using Fisher's exact test. Kruskal–Wallis tests and Spearman correlations across the four EUS grades were used as exploratory analyses of perioperative outcomes. Exact binomial confidence intervals were calculated using the Clopper–Pearson method. A post hoc receiver operating characteristic (ROC) analysis of EUS grade for segmental resection, including the internally derived Youden threshold and bootstrap confidence interval, is reported in Online Resources 1 and 3.

In the paired subgroup, EUS and MRI detection proportions relative to the operative reference definition were compared using the exact McNemar test. A sensitivity analysis excluding the patient with malignant transformation of endometriosis was performed for perioperative comparisons. No formal sample-size calculation was performed; the analysis comprised all patients identified from the retrospective record review who met the eligibility criteria. No imputation was performed, and paired MRI–EUS analysis was restricted to the 21 patients with both examinations available. All tests were two-sided. Given the exploratory nature of the secondary analyses, the limited sample size, and the absence of adjustment for multiple comparisons, *P* values and confidence intervals were interpreted cautiously. Analyses were performed using Python 3.13 (pandas 3.0.2 and SciPy 1.17.1).

Results

Patient characteristics and surgical management

Twenty-five patients were included. Mean age was 37.4 years (range, 28–45 years), and mean body mass index was 22.4 kg/m². Dysmenorrhea was present in 22 patients (88.0%), anal fullness in 6 (24.0%), altered bowel habits in 5 (20.0%), and dyspareunia in 4 (16.0%). Ovarian endometrioma was present in 17 patients (68.0%), adenomyosis in 12 (48.0%), and uterine fibroids in 11 (44.0%; Table 1).

Table 1
Baseline characteristics of the study cohort.

Variable	Value
Patients, n	25
Age, years, mean (range)	37.4 (28–45)
Body mass index, kg/m ² , mean (range)	22.4 (17.1–28.6)
Dysmenorrhea, n (%)	22 (88.0)
Anal fullness, n (%)	6 (24.0)
Altered bowel habits, n (%)	5 (20.0)
Dyspareunia, n (%)	4 (16.0)
Ovarian endometrioma, n (%)	17 (68.0)
Adenomyosis, n (%)	12 (48.0)
Uterine fibroids, n (%)	11 (44.0)

EUS grades 0, 1, 2, and 3 were assigned to 5, 4, 11, and 5 patients, respectively. Surgical-management grades 0, 1, 2, and 3 were observed in 8, 3, 4, and 10 patients, respectively (Fig. 1; Table 2). De-identified patient-level EUS grades, surgical-management grades, and perioperative variables are provided in Online Resource 2.

Table 2
Cross-tabulation of EUS grade and surgical-management grade.

EUS grade	Grade 0: no therapeutic bowel-wall treatment	Grade 1: bowel-wall treatment without resection	Grade 2: discoid/local resection	Grade 3: segmental resection	Total
0	4	1	0	0	5
1	3	1	0	0	4
2	1	1	3	6	11
3	0	0	1	4	5
Total	8	3	4	10	25

EUS, endoscopic ultrasonography.

Association between EUS grade and surgical management

Higher EUS grades were associated with more extensive bowel surgical management (Spearman's $\rho = 0.77$, $P < 0.001$). Segmental resection was performed in 10 of 16 patients (62.5%) with EUS grades 2–3, compared with none of the 9 patients with grades 0–1 (0%; Fisher's exact test, two-sided $P = 0.003$). The corresponding proportions were 62.5% (95% CI 35.4–84.8%) and 0% (95% CI 0–33.6%), respectively.

Perioperative outcomes

Across the cohort, median blood loss was 50 mL (IQR 30–100 mL), median operative time was 160 min (IQR 90–240 min), and median hospital stay was 8 days (IQR 7–10 days; Table 3). Patients with EUS grades 2–3 had higher estimated blood loss, longer operative time, and longer hospital stay than those with grades 0–1. Corresponding medians were 50 versus 30 mL ($P = 0.032$), 222.5 versus 75 min ($P = 0.002$), and 10 versus 6 days ($P < 0.001$), respectively. The interval from EUS to surgery did not differ between groups (median 20 versus 28 days; $P = 0.955$).

Patients who underwent segmental resection also had greater blood loss, longer operative time, and longer hospital stay than those managed without segmental resection (Table 3). Across the four EUS grades, operative time and hospital stay differed significantly (Kruskal–Wallis $P = 0.020$ and $P = 0.007$, respectively), whereas blood loss did not ($P = 0.151$). EUS grade was positively associated with operative time (Spearman's $\rho = 0.55$, $P = 0.004$) and hospital stay ($\rho = 0.59$, $P = 0.002$), but not significantly with blood loss ($\rho = 0.36$, $P = 0.081$).

The patient with malignant transformation of endometriosis (EUS grade 2, managed with segmental resection) was retained in the primary analysis. In a sensitivity analysis excluding this patient ($n = 24$), the grades 2–3 group continued to have greater blood loss (50 versus 30 mL, $P = 0.040$), longer operative time (215 versus 75 min, $P = 0.003$), and longer hospital stay (10 versus 6 days, $P = 0.001$) than the grades 0–1 group.

Table 3
Perioperative outcomes according to EUS grade group and segmental-resection status.

Outcome	EUS grade 0–1 (n = 9)	EUS grade 2–3 (n = 16)	<i>P</i> value	No segmental resection (n = 15)	Segmental resection (n = 10)	<i>P</i> value
Blood loss, mL	30 (20–50)	50 (50–125)	0.032	30 (20–50)	75 (50–175)	0.016
Operative time, min	75 (61–95)	222.5 (156.2–281.2)	0.002	95 (72.5–147.5)	260 (215–296.2)	0.002
Hospital stay, days	6 (5–7)	10 (8.8–11)	< 0.001	7 (5.5–8)	10.5 (10–11)	< 0.001
Interval from EUS to surgery, days	28 (5–36)	20 (16.5–22.8)	0.955	—	—	—

Values are median (interquartile range). *P* values were obtained using the Mann–Whitney U test.

Paired EUS–MRI findings

Among the 21 patients who underwent both examinations, all met the operative reference definition of rectosigmoid involvement. EUS identified involvement in 17 patients (81.0%), whereas MRI identified involvement in 11 (52.4%). There were 8 EUS-positive/MRI-negative cases and 2 MRI-positive/EUS-negative cases. The paired difference was not statistically significant by exact McNemar test ($P = 0.109$; Table 4). These data describe the paired detection pattern within an operative-positive subgroup and do not establish comparative diagnostic accuracy.

Exploratory apparent-discrimination estimates for segmental resection, including the post hoc threshold analysis, are provided in Online Resources 1 and 3.

Table 4
Paired EUS and MRI findings among 21 patients with operative evidence of rectosigmoid involvement.

Finding	n
EUS positive, MRI negative	8
MRI positive, EUS negative	2
Both positive	9
Both negative	2
Total	21

EUS identified involvement in 81.0% (17/21) and MRI in 52.4% (11/21). The exact McNemar test yielded $P = 0.109$. Because all 21 patients met the operative reference definition, specificity and overall diagnostic accuracy could not be estimated.

Discussion

In this retrospective surgical cohort, higher preoperative EUS wall-layer grades were associated with progressively more extensive bowel surgical management in rectosigmoid DIE. The ordinal relationship was substantial, and the grouped analysis was clinically consistent: segmental resection was performed in 62.5% of patients with EUS grades 2–3 and in none with grades 0–1. These findings suggest that EUS wall-layer assessment can add practical information when clinicians and patients discuss the possible extent of bowel intervention before surgery.

The potential contribution of EUS is best understood within multidisciplinary preparation rather than as a stand-alone operative rule. A higher EUS grade may alert the gynecologic team to the possibility of more extensive bowel-wall management, facilitate timely discussion with colorectal colleagues, and support counselling about a range of bowel-sparing and resection procedures. The choice between conservative, discoid, and segmental procedures also reflects symptoms, fertility goals, lesion distribution, adhesions, associated pelvic disease, technical feasibility, and intraoperative findings [12–13]. Thus, EUS grade may help clinicians anticipate and discuss surgical options, but should not independently determine segmental resection.

The perioperative findings are also clinically coherent. Patients with EUS grades 2–3 had longer operations, greater estimated blood loss, and longer hospital stays, while patients undergoing segmental resection had a similar pattern. These associations likely reflect a combination of underlying disease extent and the procedures undertaken, rather than an independent effect of the EUS grade itself. In this context, they support the clinical relevance of preoperative EUS stratification for planning operative resources and perioperative counselling. The paired MRI analysis likewise supports complementarity between modalities. EUS offers detailed information on rectosigmoid wall layers, whereas MRI provides broader pelvic mapping and may better identify disease outside the EUS field of view or other features requiring attention. Although EUS identified rectosigmoid involvement more often than MRI in the paired operative-positive subgroup, the difference was not statistically significant and the subgroup could not provide specificity or full accuracy estimates. The patient with malignant transformation of endometriosis further illustrates the need to interpret EUS together with MRI and other clinical information when malignant disease is suspected.

This study has limitations. It was a small, single-center retrospective surgical cohort in which EUS was selected according to clinical judgment; the findings may therefore not generalize to all patients with DIE. The operating team had access to EUS reports, so the observed relationship reflects both disease extent and the clinical decision pathway in which EUS contributed to management. EUS grades were assigned from original report text without systematic image or video rereview, and reproducibility could not be

assessed. Surgical management is a clinical endpoint rather than an independent histopathologic reference standard, and the operative definition used for the paired MRI analysis included dense adhesions as well as direct bowel-wall involvement. Perioperative comparisons were unadjusted, and postoperative complications, bowel function, lesion dimensions, and structured #Enzian data were not systematically available. The latter limitation restricts direct comparison with standardized non-invasive and surgical descriptions of DIE [15–16]. Finally, the ROC analysis was post hoc and evaluated in the same cohort; its apparent performance estimates require validation in larger prospective multicenter studies with standardized imaging and operative reporting.

Conclusion

Higher preoperative EUS wall-layer grades were associated with more extensive bowel surgical management in rectosigmoid DIE. EUS wall-layer assessment may complement preoperative counselling and multidisciplinary planning by helping clinicians anticipate the possible extent of bowel intervention and the need for operative resources. Larger prospective studies are needed to define its role within standardized preoperative assessment pathways.

Declarations

Ethics approval and consent to participate

The study protocol was approved by the Ethics Committee of the First Affiliated Hospital of the Air Force Medical University (approval number: KY20252314-C-1). The requirement for informed consent to participate was waived by the Ethics Committee because this retrospective study used previously collected de-identified data. The study was conducted in accordance with the Declaration of Helsinki.

Consent for publication

Not applicable. No personally identifiable information is included in this manuscript.

Competing interests

Weina Kong, Jia Xi, Boyi Ma, Hong Yang, and Shuhua Zhao declare that they have no financial or non-financial competing interests.

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and edited an earlier draft of the manuscript; the authors retained full responsibility for the final content and the decision to publish.

Author Contribution

WNK and SHZ: Study design, data analysis and manuscript writing; JX and BYM: Data collection; HY: Funding acquisition, Provided clinical expertise and supervision. All authors revised manuscript and approved final draft.

Data Availability

The de-identified dataset used in this study is not publicly available because of institutional and patient-privacy restrictions but may be available from the corresponding author on reasonable request, subject to ethics approval.

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Figures

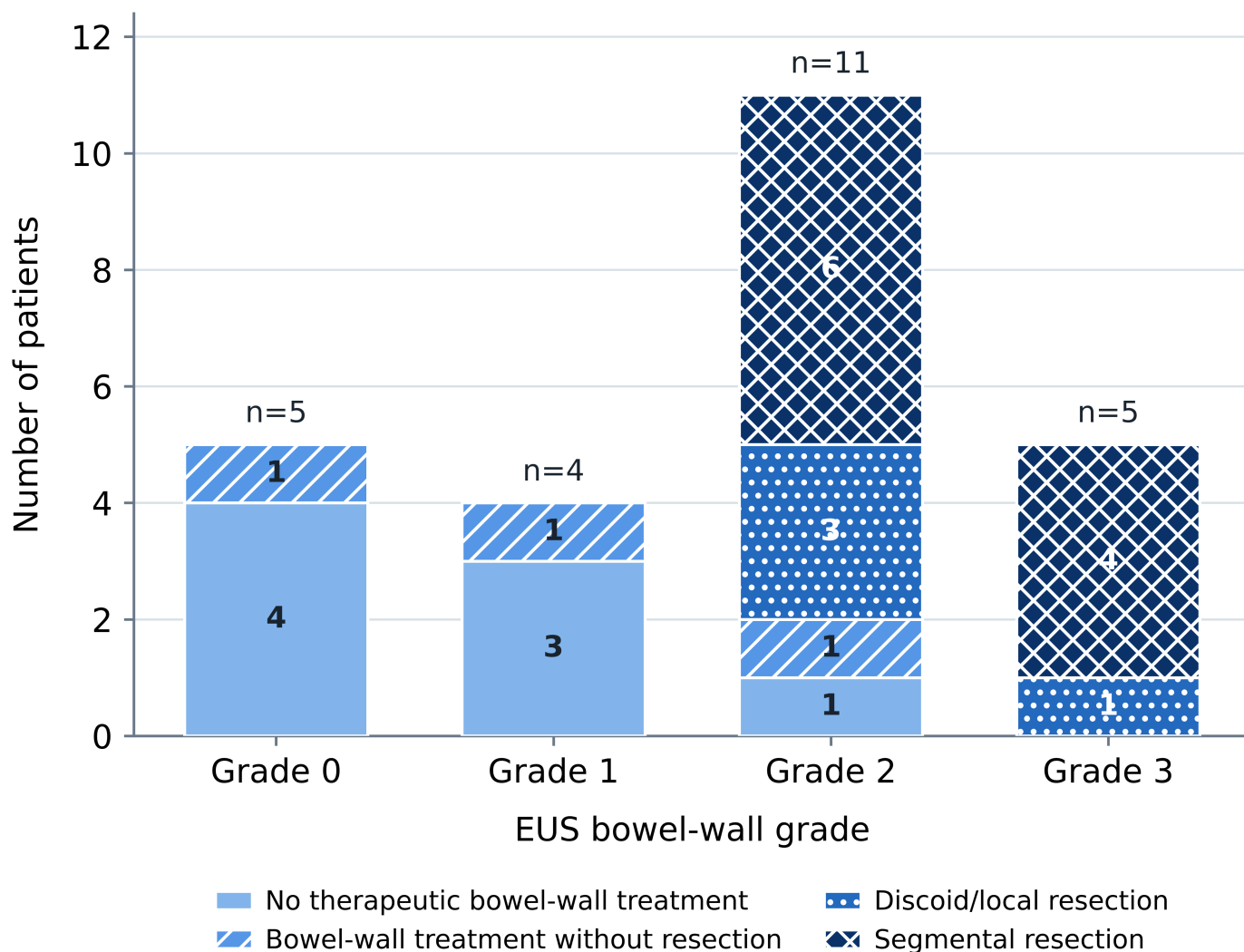


Figure 1

Distribution of bowel surgical management according to EUS bowel-wall grade. The x-axis shows EUS grades 0–3 and the y-axis shows the number of patients. Colors and patterns indicate no therapeutic bowel-wall treatment, bowel-wall treatment without resection, discoid or local resection, and segmental resection. In-bar labels show patient counts, and labels above the bars show the total number of patients in each EUS-grade group

Supplementary Files

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