Conservative surgery versus colorectal resection for endometrial deposits: a systematic review and meta-analysis of surgical and long-term outcomes

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Abstract

PURPOSE: The optimal surgical approach for removal of colorectal endometrial deposits is unclear. Shaving and discoid excision of colorectal deposits allow organ preservation but risk recurrence with associated functional issues and re-operation. Formal resection risks potential higher complications but may be associated with lower recurrence rates. This meta-analysis compares peri-operative and long-term outcomes between conservative surgery (shaving and disc excision) versus formal colorectal resection.

METHODS: The study was registered with PROSPERO. A systematic search was performed on PubMed and EMBASE databases. All comparative studies examining surgical outcomes in patients that underwent conservative surgery versus colorectal resection for rectal endometrial deposits were included. The two main groups (conservative versus resection) were compared in three main blocks of variables including group comparability, operative outcomes and long-term outcomes.

RESULTS: Seventeen studies including 2861 patients were analysed with patients subdivided by procedure: colorectal resection (n=1389), shaving (n=703) and discoid excision (n=742). When formal colorectal resection was compared to conservative surgery there was lower risk of recurrence (p=0.002), comparable functional outcomes (minor LARS, p=0.30, major LARS, p=0.54), similar rates of postoperative leaks (p=0.22), pelvic abscesses (p=0.18) and rectovaginal fistula (p=0.92). On subgroup analysis, shaving had the highest recurrence rate (p=0.0007), however a lower rate of stoma formation (p=0.00001) and rectal stenosis (p=0.01). Discoid excision and formal resection were comparable.

CONCLUSION: Colorectal resection has a significantly lower recurrence rate compared to shaving. There is no difference in complications or functional outcomes between discoid excision and formal resection and both have similar recurrence rates.

Introduction

Endometriosis is a chronic, potentially debilitating disease affecting up to 15% of women of reproductive age1,2. Deep infiltrating endometriosis (DIE) is defined as endometrial deposits located more than 5mm beneath the peritoneal surface and can frequently affect the uterosacral ligaments, pelvic side walls, rectovaginal septum, vagina, bowel, bladder, or ureter1. Due to its wide pattern of distribution in the peritoneal cavity, DIE is a challenging disease, causing a wide range of symptoms, delay in diagnosis3,4 and often requiring multidisciplinary involvement5,6. The bowel is affected in up to 12% of patients, with 90% of lesions located in the sigmoid colon or rectum7,8.

If medical treatment fails, surgical management of endometriosis is indicated when lesions are symptomatic and impairing gastrointestinal, urinary, sexual or reproductive functions. The main surgical approaches currently used in the management of colorectal deposits include formal rectal resection and conservative surgery, either by shaving (S) of superficial endometrial deposits or by full thickness disc excision (DE) of deeper ones. The 2022 European Society of Human Reproduction and Embryology (ESHRE) Endometriosis Guidelines don't specify which specific surgical technique is preferable and instead suggest that a tailored approach be taken for each patient9. This means one must first define the size, number and degree of infiltration within the intestinal wall on T2 weighted MRI sequences. MRI and endoscopy findings, patient preference, surgeon expertise and intraoperative findings usually dictate type of technique used.

There has been a trend towards conservative surgery (shaving or discoid excision) as it seems to be associated with less postoperative complications based on retrospective studies, but may lead to incomplete excision, higher rate of recurrence and requirement of reoperation with resection in a challenging pelvis. Formal colorectal resection is the most radical approach which should ensure a lower risk of recurrence; however, it can be argued that it may be associated with more postoperative complications and worse functional outcomes. There is a need to define surgical standards in the management of colorectal endometriosis as currently there is no clear consensus. To enable better decision making among surgeons involved in the management of colorectal endometriosis we performed this systematic review and meta-analysis to compare surgical and long-term outcomes between conservative surgery (shaving and discoid excision) versus formal colorectal resection.

Materials And Methods

Literature Search and Study Selection

The study protocol was registered with PROSPERO (International Prospective Register of Systematic Reviews). The study ID is CRD42022336218. A systematic search of PubMed and EMBASE databases was performed for all comparative studies examining surgical outcomes in patients that underwent conservative (shaving or disc excision) versus formal colorectal resection for rectal endometriosis. The following search algorithm was used: (Rectal AND Endometriosis) AND (resection). Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were used as search protocol and the PRISMA checklist was followed to conduct the methodology10 (Fig. 1). Inclusion criteria were used according to the Problem, Intervention, Comparison and Outcome (PICO) formula. The latest search was performed on 29th May 2022. Two authors (LOB and SM) assessed the titles and abstracts of studies found in the search and the full texts of potentially eligible trials were reviewed. Disagreements were resolved by consensus-based discussion. The Newcastle-Ottawa scale (Table 1) and the ROBINS-I tool11 (Fig. 2) were used to quantify quality of eligible studies. The references of full texts were further screened for additional eligible studies. The corresponding author was contacted to clarify data extraction if additional information was necessary.
Statistical Analysis
analysed for the S and DE subgroups and comparing each technique with resection.

stula, rectal stenosis) and long-term outcomes (rectal recurrence, development of LARS). The operative and long terms outcomes were also assessed for eligibility. The primary end points were leak rate, stoma requirement and rectal endometriosis recurrence. Secondary end points included operative time, length of hospital stay, postoperative morbidity (pelvic abscesses, rectovaginal fistula, rectal stenosis) and functional outcomes measured by incidence of minor and major low anterior resection syndrome (LARS) in the studied cohort. Studies without comparative data between one conservative approach and formal resection were not included.

Eligibility Criteria
Studies written in English including comparative surgical data between conservative and colorectal resection for rectal endometrial deposits were assessed for eligibility. The primary end points were leak rate, stoma requirement and rectal endometriosis recurrence. Secondary end points included operative time, length of hospital stay, postoperative morbidity (pelvic abscesses, rectovaginal fistula, rectal stenosis) and functional outcomes measured by incidence of minor and major low anterior resection syndrome (LARS) in the studied cohort. Studies without comparative data between one conservative approach and formal resection were not included.

Data Extraction and Outcomes
For each eligible study the following data was recorded: author’s names, journal, year of publication, study type, total number of patients and number of patients included in each group, main operator (gynaecologist/colorectal/combined), mean age, mean BMI, surgical history, symptoms relating to rectal endometriosis (constipation, diaphoresis, dyschezia, dyspareunia), American Society for Reproductive Medicine (ASRM) endometriosis stage, Enzian C grade, operative time, postoperative complications (leak rate, stoma formation, pelvic abscesses, rectovaginal fistula and rectal stenosis) length of stay, disease recurrence, low anterior resection syndrome (LARS) grading. The type of procedure was recorded and defined as: conservative approach (C) sub-grouped as shaving of endometrial deposits (S) or discoid excision (DE) and formal segmental resection (SR). The two main groups (conservative versus resection) were compared in a meta-analytical model for group comparability (previous surgeries, ASRM endometriosis staging, Enzian C grades), operative outcomes (operative time, length of stay, need for stoma formation, leak rate, pelvic abscesses, rectovaginal fistula, rectal stenosis) and long-term outcomes (rectal recurrence, development of LARS). The operative and long terms outcomes were also analysed for the S and DE subgroups and comparing each technique with resection.

Table 1
Study characteristics

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Key: Gyne, gynaecologist; MDT, multidisciplinary teams; C, conservative; S, shaving; DE, disc excision; SR, segmental resection; BMI, body mass index; NOS, Newcastle-Ottawa scale

Statistical Analysis
As previously demonstrated\textsuperscript{12–14}, random-effects models were used to measure all pooled outcomes as described by Der Simonian and Laird\textsuperscript{16}. For dichotomous variables the odds ratio (OR) was estimated with its variance and 95% confidence interval (CI) while for continuous data mean difference was used at 95% CI. The random effects analysis weighted the natural logarithm of each study's OR by the inverse of its variance plus an estimate of the between-study variance in the presence of between-study heterogeneity. Heterogeneity between ORs for the same outcome between different studies was assessed using the $I^2$ inconsistency test and chi-square-based Cochran's Q statistic test in which $p < 0.05$ is taken to indicate the presence of significant heterogeneity. Analyses were conducted using Review Manager 5.3.

**Results**

**Eligible studies**

Seventeen studies\textsuperscript{16–32} containing data comparing conservative versus formal resection of rectal endometriosis were included (Table 1). The initial search found 1647 studies. After excluding duplicates and unrelated studies based on abstract triage, 30 full texts were assessed for eligibility, out of which 17 matched the inclusion criteria and were analyzed. Year of publication of included studies ranged from 2010 to 2021. There was one randomized controlled trial (RCT), fourteen retrospective studies and two prospective. The total number of included patients was 2861, split into two groups: conservative group (C, $n = 1472$) and segmental resection group (SR, $n = 1389$). The conservative group was further split in two subgroups depending on type of procedure: shaving of endometrial deposits (S, $n = 703$) and discoid excision of deposits (DE, $n = 742$).

**Group comparability**

Mean age in the C group was 33 vs 33.4 in the SR group. Mean BMI was 23.3 in the C group and 23.4 in the SR group. The operative team was formed by both a gynecological and a colorectal surgeon in ten studies\textsuperscript{16–21} while in seven\textsuperscript{16,17,27–29,32} the main operator was a gynecological surgeon.

**Previous surgery for endometriosis**

Five studies\textsuperscript{16,19,20,21,23} describing 1323 patients reported how many patients had previous laparoscopies for endometriosis. No significant difference was found between the two main groups (OR: 0.84, 95% CI: [0.50, 1.4], $p = 0.50$, $\chi^2 = 12.39$, $I^2 = 68\%$) (Fig. 3A).

Six studies\textsuperscript{16,17,19,20,21,23} including 1415 patients reported how many patients had previous laparotomies. There was no significant difference between the two groups (OR: 0.77, 95% CI: [0.39, 1.53], $p = 0.46$, $\chi^2 = 13.38$, $I^2 = 63\%$) (Fig. 3B).

**Endometriosis (ASRM) staging**

Five studies\textsuperscript{16,18–26} including 1084 patients provided data on preoperative staging according to the ASRM endometriosis staging. Significantly more patients with stages 1 and 2 were allocated to the C group and underwent conservative surgery either by shaving or by disc excision (OR: 2.06, 95% CI: [1.28,3.33], $p = 0.003$, $\chi^2 = 5.10$, $I^2 = 22\%$) (Fig. 4A). There was no significant difference in allocation of stage 3 patients between the two groups (OR: 1.71, 95% CI: [0.89,3.29], $p = 0.10$, $\chi^2 = 7.64$, $I^2 = 48\%$) (Fig. 4B). There were less patients with stage 4 disease in the C group (OR: 0.46, 95% CI: [0.31,0.69], $p = 0.0001$, $\chi^2 = 5.63$, $I^2 = 29\%$) (Fig. 4C).

**Endometriosis Enzian C grading**

Six studies\textsuperscript{16,19–21,23,26} including 1433 patients provided data on preoperative Enzian C grading of rectal endometriosis. There was no significant difference for C1 grading (OR: 2.99, 95% CI: [0.33, 27.35], $p = 0.33$, $\chi^2 = 50.37$, $I^2 = 92\%$) (Fig. 5A). Significantly more C2 patients underwent conservative surgery (OR: 1.83, 95% CI: [1.07, 3.14], $p = 0.03$, $\chi^2 = 15.41$, $I^2 = 68\%$) (Fig. 5B) while significantly more patients with C3 rectal endometriosis underwent segmental resection (OR: 0.40, 95% CI: [0.17, 0.95], $p = 0.04$, $\chi^2 = 37.27$, $I^2 = 87\%$) (Fig. 5C), although data showed significant heterogeneity.

**Operative outcomes**

**Operative time**

Overall, ten studies\textsuperscript{16,17,19,20,22,25–28,32} including 1739 patients measured the operative time for the two main groups. Conservative surgery was associated with a significantly shorter operative time (mean difference: 46.22 minutes, 95% CI: [18.49, 73.96], $p = 0.001$, $\chi^2 = 100.69$, $I^2 = 92\%$) (Fig. 6A). When the subgroups were analysed (shaving vs SR and discoid excision vs SR), shaving had the shortest operative time (mean difference: 80.58 minutes, 95% CI: [49.18, 111.97], $p < 0.00001$, $\chi^2 = 49.20$, $I^2 = 92\%$) (Fig. 6B). Similarly, discoid excision showed a significantly shorter operative time compared to SR (mean difference: 33.89 minutes, 95% CI: [15.85, 51.93], $p = 0.0002$, $\chi^2 = 10.76$, $I^2 = 54\%$) (Fig. 6C).

**Length of hospital stay**
Overall, seven studies \(17,18,20,22,26,28,29\) including 1159 patients had data on the length of stay. Conservative surgery was associated with a significant shorter hospital stay with a mean difference of 1.51 days, 95% CI: \([0.55, 2.46]\), \(p = 0.002\), \(\chi^2 = 29.19, I^2 = 83\%\) (Fig. 7A). When analysing the subgroups, the shorter hospital stay remained valid only for the DE group (mean difference: 0.96 days, 95% CI: \([0.36, 1.55]\), \(p = 0.002\), \(\chi^2 = 10.64, I^2 = 62\%\)) (Fig. 7B) while S was not associated with a significant shorter stay (mean difference: 1.51 days, 95% CI: \([0.73, 3.76]\), \(p = 0.002\), \(\chi^2 = 21.25, I^2 = 91\%\)) although data showed high heterogeneity (Fig. 7C).

### Stoma requirement

Thirteen studies \(16–19,21,22–24,26,28,30–32\) including 2483 patients provided data on the need for stoma diversion (loop ileostomy or loop colostomy). Overall, conservative surgery was associated with less stoma formation compared to segmental resection (OR: 5.56, 95% CI: \([1.91, 16.18]\), \(p = 0.002\), \(\chi^2 = 10.64, I^2 = 62\%\)) (Fig. 8A). On subgroup analysis, less stoma requirement was only seen when S was compared to SR with no significant heterogeneity (OR: 0.07, 95% CI: \([0.01, 2.19]\), \(p = 0.35\), \(\chi^2 = 0.08, I^2 = 0\%\)) (Fig. 8B) while for DE there was no significant difference in terms of stoma requirement when compared to SR (OR: 0.59, 95% CI: \([0.26, 1.35]\), \(p = 0.21\), \(\chi^2 = 54.05, I^2 = 83\%\)) (Fig. 8C).

### Leak rate

Nine studies \(17–20,22,26,27,30,31\) including 1129 patients provided data on the rate of postoperative leaks between the two groups. Overall, there was no significant difference in terms of leaks between the two main groups with no heterogeneity (OR: 0.55, 95% CI: \([0.21, 1.44]\), \(p = 0.22\), \(\chi^2 = 2.26, I^2 = 0\%\)) (Fig. 9A) and the results remained similar on subgroup analysis (Fig. 9B, Fig. 9C).

### Pelvic abscesses

Ten studies \(16–19,21,22,26,27,30,31\) including 1825 patients provided data on the rate of postoperative pelvic abscesses in the two main groups. Overall, there was no significant difference between conservative surgery and segmental resection with low inter-study heterogeneity (OR: 0.73, 95% CI: \([0.47, 1.16]\), \(p = 0.18\), \(\chi^2 = 9.86, I^2 = 9\%\)) (Fig. 10A) and the results remained similar on subgroup analysis (Fig. 10B, Fig. 10C).

### Rectovaginal fistula

Ten studies \(16–19,21,22,26,27,30,31\) including 1503 patients had data on the rate of rectovaginal fistula formation in the two main groups. Overall, there was no significant difference between conservative surgery and segmental resection (OR: 0.96, 95% CI: \([0.47, 1.99]\), \(p = 0.92\), \(\chi^2 = 9.02, I^2 = 22\%\)) (Fig. 11A) however on subgroup analysis shaving was associated with fewer rectovaginal fistulas with no inter-study heterogeneity (OR: 0.32, 95% CI: \([0.09, 1.11]\), \(p = 0.07\), \(\chi^2 = 0.08, I^2 = 0\%\)) (Fig. 11B). Discoid excision showed similar rates of rectovaginal fistulas compared to segmental resection (OR: 1.18, 95% CI: \([0.62, 2.26]\), \(p = 0.61\), \(\chi^2 = 4.09, I^2 = 0\%\)) (Fig. 11C).

### Rectal stenosis

Ten studies \(16,18,19,21,22,26,28,29,31,32\) including 2083 patients provided data on the incidence of postoperative rectal stenosis between the two main groups. Overall, conservative surgery showed a smaller rate of rectal stenosis development compared to segmental resection with low heterogeneity (OR: 0.26, 95% CI: \([0.09, 0.72]\), \(p = 0.009\), \(\chi^2 = 11.35, I^2 = 21\%\)) (Fig. 12A). On subgroup analysis, shaving was associated with a 6 fold higher recurrence rate (OR: 6.44, 95% CI: \([2.19, 18.94]\), \(p = 0.0007\), \(\chi^2 = 4.42, I^2 = 9\%\)) (Fig. 12B) while for discoid excision recurrence was comparable to formal resection (OR: 3.13, 95% CI: \([0.71, 13.78]\), \(p = 0.13\), \(\chi^2 = 0.29, I^2 = 0\%\)) (Fig. 12C).

### Long term outcomes

#### Disease recurrence

Four studies \(16,25,28,31\) including 698 patients analysed recurrence rates between the two groups. In all cases recurrence was confirmed intraoperatively. Overall, there were fewer recurrences seen in the segmental resection group with no inter study heterogeneity (OR: 5.56, 95% CI: \([1.91, 16.18]\), \(p = 0.002\), \(\chi^2 = 25, I^2 = 0\%\)) (Fig. 13A). Shaving was associated with a 6 fold higher recurrence rate (OR: 6.44, 95% CI: \([2.19, 18.94]\), \(p = 0.0007\), \(\chi^2 = 3.25, I^2 = 0\%\)) (Fig. 13B) while for discoid excision recurrence was comparable to formal resection (OR: 3.13, 95% CI: \([0.71, 13.78]\), \(p = 0.13\), \(\chi^2 = 0.29, I^2 = 0\%\)) (Fig. 13C).

#### Functional outcomes (LARS)

Three studies \(19,23,26\) including 511 patients provided data on development of low anterior resection syndrome (LARS) in the two main groups. Subgroup analysis was not possible due to insufficient data. The two main groups (C vs SR) were compared in terms of minor LARS and major LARS
Development. There was no significant difference in both minor LARS (OR: 0.71, 95% CI: [0.37, 1.35], p = 0.30, $\chi^2 = 2.86, I^2 = 30\%$) (Fig. 14A) and major LARS (OR: 1.25, 95% CI: [0.61, 2.59], $p = 0.54, \chi^2 = 3.01, I^2 = 33\%$) (Fig. 14B) with low inter study heterogeneity.

**Discussion**

This meta-analysis demonstrates that formal resection is associated with a significantly lower recurrence rate of rectal endometriosis compared to conservative surgery. When shaving and discoid excision were considered separately there is a 6-fold increase in recurrence with shaving and no major difference in recurrence between formal resection and discoid excision. Stoma requirement and complications such as rectal stenosis and rectovaginal fistula are lower in shaving as expected but are similar in formal resection and disc excision. When long term function is assessed, there is no difference in reported outcomes between conservative surgery and formal resection.

This is the most up-to-date meta-analysis$^{33-35}$ on conservative versus colorectal resection for rectal endometriosis and the first one to compare both the two main groups and also the subgroups (S vs SR, DE vs SR) in terms of group comparability (previous surgeries, endometriosis staging and Enzian C grading), surgical outcomes and long-term outcomes. While shaving is associated with fewer postoperative complications and the shortest operative time, discoid excision is comparable to colorectal resection in terms of complications. Another important issue to consider is regarding patient allocation to each procedure. Our study showed that more patients with severe (stage 4) endometriosis and Enzian C grading (infiltrating rectal nodule more than 3 cm in diameter) were allocated to the colorectal resection group while more patients with stages 1 and 2 (minimal and mild) underwent conservative surgery. This is an obvious result and reflects clinical practice where surgeons choose procedures based on the severity of the disease to ensure complete removal of the nodules and avoid recurrence. The results of this study endorse such practice. It is reasonable to consider shaving for small nodules as it spares the rectal wall and reduces risk of complications, but the chance of incomplete excision and recurrence is significantly higher. Importantly, there appears to be potential long term functional issues after shaving as those undergoing resection do not have different LARS outcomes to those with shaving. It is possible that recurrent lesions in the shaving group account for the similarity in function between the two groups. For large or multiple nodules, colorectal resection offers the best chance of cure, without a significant increase in major surgical complications such as leaks, pelvis abscess or fistula formation and similar functional outcomes.

There are limitations to this study based on the retrospective nature of data in most of the included studies, however due to the low prevalence of rectal endometriosis and heterogenous presentation it is difficult and unlikely to perform quality randomized controlled trials. Only one RCT$^{32}$ was done on this subject which analysed functional outcomes between conservative surgery and segmental resection and included only DIE affecting over 50% of the rectal circumference. Functional outcomes were similar between the two groups, while formal resection showed an increased risk of long-term stenosis, similar to our meta-analysis, however both shaving and discoid excision were included in the conservative group; thus, it is possible that the higher rate of rectal stenosis may have been determined by the shaving subgroup, as it was the case in our analysis. If possible, further RCTs or propensity case matched studies should aim to reduce selection bias by comparing outcomes between each of the three procedures per stage and grading of endometriat nodules.

**Conclusion**

Resection and discoid excision are associated with a lower risk of rectal endometriosis recurrence compared to shaving. Functional outcomes between conservative surgery and resection are the not different. Shaving is associated with lower complication rates but both discoid excision and resection have comparable stoma requirement and complications. For isolated smaller lesions discoid excision would be reasonable but formal resection can be considered without higher likelihood of complications or long-term impairment of function.

**Declarations**

**Conflict of interest statement**

The authors have no conflicts of interest to disclose. The results of this study were never published or presented elsewhere.

**Funding statement**

No funding or financial assistance was received by the authors.

**Author contributions**

All authors contributed to the study conception and design. Luke O’Brien, Stefan Morarasu, Cillian Clancy, Paul C Neary, Mihail Gabriel Dimofte, Sorinel Lunca designed the study and approved the study protocol. Luke O’Brien, Stefan Morarasu, Bianca Codrina Morarasu, Ana Maria Musina, Natalia Velenciuc, Cristian Ene Roata performed the literature search. Luke O’Brien, Stefan Morarasu, Cillian Clancy analysed the data. Luke O’Brien, Stefan Morarasu, Cillian Clancy, Bianca Codrina Morarasu, Ana Maria Musina, Natalia Velenciuc, Cristian Ene Roata, Diego Raimondo, Renato Seracchioli, Paolo Casadio prepared the manuscript. Diego Raimondo, Renato Seracchioli and Paolo Casadio provided raw patient data for subgroup analysis. Cillian Clancy, Paul C Neary, Mihail Gabriel Dimofte, Sorinel Lunca, Diego Raimondo, Renato Seracchioli and Paolo Casadio critically reviewed the final manuscript. All authors read and approved the final manuscript.
References


Figures
Figure 1

PRISMA flowchart

Records identified through database search
n = 1,647
PubMed (394)
EMBASE (1,253)

Records after duplicates removed
n = 1,317

Articles excluded by title and abstract (n = 1,286)
Reasons:
- Case reports (264)
- Describing imaging techniques (162)
- No comparative data (272)
- No full text available (6)
- Surgical technique studies (224)
- Unrelated (358)

Full-text articles assessed for eligibility
n = 30

Full-text articles excluded
(n = 13)
Reasons:
- No relevant comparison between techniques (10)
- Not in English (1)
- Full text not accessible (1)
- Same author, same cohort (1)

Studies included in meta-analysis
n = 17
Figure 2

ROBINS-I Risk of bias assessment. Assessment of risk of bias was done by two authors (LOB and SM). Each study was classified as low/moderate/serious/critical risk for each of the seven domains. Disagreements were resolved via consensus.
Figure 3

Meta analysis of previous surgical interventions for endometriosis: (a) previous laparoscopies; (b) previous laparotomies

Legend: Each study is shown by the point estimate of the odds ratio/mean difference (OR/MD; square proportional to the weight of each study) and 95% confidence interval (CI) for the OR (extending lines); the combined ORs/mean difference and 95% CIs by random effects calculations are shown by diamonds.

(b) C versus SR and previous laparotomies (n=1415, p=0.46; test for heterogeneity Cochran Q: 13.38, df: 5, p=0.02, I²: 63%)

(a) C versus SR and previous laparoscopies (n=1323, p=0.50; test for heterogeneity Cochran Q: 12.39, df: 4, p=0.01, I²: 68%)

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<th>Conservative Events</th>
<th>Segmental Resection Events</th>
<th>Total</th>
<th>Weight</th>
<th>Odds Ratio M-H, Random, 95% CI</th>
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<tr>
<td>Abo 2018</td>
<td>36</td>
<td>225</td>
<td>9</td>
<td>139</td>
<td>17.9% 2.75 [1.28, 5.91]</td>
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<tr>
<td>Bokor 2020</td>
<td>27</td>
<td>66</td>
<td>88</td>
<td>139</td>
<td>21.2% 0.72 [0.40, 1.31]</td>
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<tr>
<td>Bonin 2019</td>
<td>23</td>
<td>64</td>
<td>45</td>
<td>87</td>
<td>19.8% 0.52 [0.27, 1.01]</td>
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<tr>
<td>Braund 2020</td>
<td>17</td>
<td>165</td>
<td>37</td>
<td>266</td>
<td>20.9% 0.71 [0.39, 1.31]</td>
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<tr>
<td>Farella 2021</td>
<td>33</td>
<td>108</td>
<td>26</td>
<td>64</td>
<td>20.2% 0.64 [0.34, 1.23]</td>
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<tr>
<td><strong>Total (95% CI)</strong></td>
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<td><strong>695</strong></td>
<td><strong>100.0%</strong></td>
<td><strong>0.84 [0.50, 1.40]</strong></td>
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<td><strong>Total events</strong></td>
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<th>Weight</th>
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<tr>
<td>Abo 2018</td>
<td>35</td>
<td>225</td>
<td>9</td>
<td>139</td>
<td>20.6% 2.66 [1.24, 5.72]</td>
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<tr>
<td>Afors 2016</td>
<td>6</td>
<td>62</td>
<td>3</td>
<td>30</td>
<td>12.2% 0.96 [0.22, 4.15]</td>
</tr>
<tr>
<td>Bokor 2020</td>
<td>3</td>
<td>66</td>
<td>19</td>
<td>139</td>
<td>14.3% 0.30 [0.09, 1.06]</td>
</tr>
<tr>
<td>Bonin 2019</td>
<td>4</td>
<td>64</td>
<td>9</td>
<td>87</td>
<td>14.7% 0.58 [0.17, 1.97]</td>
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<tr>
<td>Braund 2020</td>
<td>12</td>
<td>165</td>
<td>25</td>
<td>266</td>
<td>21.3% 0.76 [0.37, 1.55]</td>
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<td>Farella 2021</td>
<td>7</td>
<td>108</td>
<td>9</td>
<td>64</td>
<td>16.9% 0.42 [0.15, 1.20]</td>
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<tr>
<td><strong>Total (95% CI)</strong></td>
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<td><strong>725</strong></td>
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<td><strong>0.77 [0.39, 1.53]</strong></td>
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<td><strong>Total events</strong></td>
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<td>Heterogeneity: Tau² = 0.44; Chi² = 13.38, df = 5 (P = 0.02); I² = 63%</td>
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Meta analysis of preoperative patient allocation, ASRM endometriosis staging: (a) stages 1 and 2; (b) stage 3; (c) stage 4

Legend: Each study is shown by the point estimate of the odds ratio/mean difference (OR/MD; square proportional to the weight of each study) and 95% confidence interval (CI) for the OR (extending lines); the combined ORs/mean difference and 95% CIs by random effects calculations are shown by diamonds.

(a) C versus SR and stage 1 and 2 (n=1084, p=0.003; test for heterogeneity Cochran Q: 5.10, df: 4, p=0.28, I²: 22%)

(b) C versus SR and stage 3 (n=1084, p=0.10; test for heterogeneity Cochran Q: 7.64, df: 4, p=0.11, I²: 48%)

(c) C versus SR and stage 4 (n=1084, p=0.0001; test for heterogeneity Cochran Q: 5.63, df: 4, p=0.23, I²: 29%)
### Figure 5

Meta analysis of preoperative patient allocation, Enzian C grading: (a) grade C1; (b) grade C2; (c) grade C3

**Legend:** Each study is shown by the point estimate of the odds ratio/mean difference (OR/MD; square proportional to the weight of each study) and 95% confidence interval (CI) for the OR (extending lines); the combined ORs/mean difference and 95% CIs by random effects calculations are shown by diamonds.

(a) C versus SR and grade C1 (n=1433, p=0.33; test for heterogeneity Cochran Q: 50.37, df = 4 (P < 0.00001), I²: 92%)

(b) C versus SR and grade C2 (n=1433, p=0.03; test for heterogeneity Cochran Q: 15.41, df = 5 (P = 0.009), I²: 68%)

(c) C versus SR and grade C3 (n=1433, p=0.04; test for heterogeneity Cochran Q: 37.27, df = 5 (P < 0.00001), I²: 87%)

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<th>Segmental Resection Events</th>
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<th>Weight</th>
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<tr>
<td>Abo 2018</td>
<td>43</td>
<td>221</td>
<td>7</td>
<td>119</td>
<td>23.3% 3.97 [1.68, 8.89]</td>
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<td>Bonin 2019</td>
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<td>1</td>
<td>87</td>
<td>16.0% 0.45 [0.02, 11.15]</td>
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<td>Braund 2020</td>
<td>8</td>
<td>165</td>
<td>35</td>
<td>266</td>
<td>23.4% 0.34 [0.015, 0.74]</td>
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<td>64</td>
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<td>Hudelst 2018</td>
<td>24</td>
<td>32</td>
<td>2</td>
<td>102</td>
<td>21.4% 150.00 [29.92, 752.12]</td>
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<tr>
<td><strong>Total (95% CI)</strong></td>
<td></td>
<td></td>
<td></td>
<td>777</td>
<td>100.0% 2.99 [0.33, 27.35]</td>
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<td><strong>Total events</strong></td>
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<td>45</td>
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<td><strong>Heterogeneity</strong></td>
<td>Tau² = 5.28; Chi² = 50.37, df = 4 (P &lt; 0.00001); I² = 92%</td>
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<tr>
<td><strong>Test for overall effect</strong></td>
<td>Z = 0.97 (P = 0.33)</td>
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<tr>
<td>Abo 2018</td>
<td>78</td>
<td>221</td>
<td>19</td>
<td>119</td>
<td>20.4% 2.87 [1.64, 5.04]</td>
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<tr>
<td>Bokor 2020</td>
<td>12</td>
<td>66</td>
<td>38</td>
<td>139</td>
<td>17.9% 0.59 [0.29, 1.22]</td>
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<td>Bonin 2019</td>
<td>11</td>
<td>64</td>
<td>10</td>
<td>87</td>
<td>14.8% 1.60 [0.63, 4.03]</td>
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<tr>
<td>Braund 2020</td>
<td>48</td>
<td>165</td>
<td>36</td>
<td>266</td>
<td>21.6% 2.62 [1.61, 4.26]</td>
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<tr>
<td>Farella 2021</td>
<td>18</td>
<td>108</td>
<td>3</td>
<td>64</td>
<td>10.8% 4.07 [1.15, 14.40]</td>
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<tr>
<td>Hudelst 2018</td>
<td>8</td>
<td>32</td>
<td>19</td>
<td>102</td>
<td>14.8% 1.46 [0.57, 3.74]</td>
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<tr>
<td><strong>Total (95% CI)</strong></td>
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<td>777</td>
<td>100.0% 1.83 [1.07, 3.14]</td>
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<td><strong>Total events</strong></td>
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<td><strong>Heterogeneity</strong></td>
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<td><strong>Test for overall effect</strong></td>
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<tr>
<td>Abo 2018</td>
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<td>93</td>
<td>119</td>
<td>20.5% 0.23 [0.14, 0.38]</td>
</tr>
<tr>
<td>Bokor 2020</td>
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<td>66</td>
<td>101</td>
<td>139</td>
<td>19.1% 1.69 [0.82, 3.51]</td>
</tr>
<tr>
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<td>76</td>
<td>87</td>
<td>17.8% 0.70 [0.29, 1.73]</td>
</tr>
<tr>
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<td>109</td>
<td>165</td>
<td>195</td>
<td>266</td>
<td>21.0% 0.71 [0.46, 1.08]</td>
</tr>
<tr>
<td>Farella 2021</td>
<td>89</td>
<td>108</td>
<td>61</td>
<td>64</td>
<td>15.1% 0.23 [0.07, 0.81]</td>
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<td>Hudelst 2018</td>
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<td>32</td>
<td>81</td>
<td>102</td>
<td>6.8% 0.00 [0.00, 0.07]</td>
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<tr>
<td><strong>Total (95% CI)</strong></td>
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<td>777</td>
<td>100.0% 0.40 [0.17, 0.95]</td>
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<td>Z = 2.08 (P = 0.04)</td>
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## Figure 6

Meta analysis of operative time: (a) C versus SR; (b) S versus SR; (c) DE versus SR

**Legend:** Each study is shown by the point estimate of the odds ratio/mean difference (OR/MD; square proportional to the weight of each study) and 95% confidence interval (CI) for the OR (extending lines); the combined ORs/mean difference and 95% CIs by random effects calculations are shown by diamonds.

(a) C versus SR and operative time (n=1647, p=0.001; test for heterogeneity Cochran Q: 100.69, df: 8, p<0.00001, I²: 92%)

(b) S versus SR and operative time (n=932, p=0.00001; test for heterogeneity Cochran Q: 49.20, df: 4, p=0.00001, I²: 92%)

(c) DE versus SR and operative time (n=809, p=0.0002; test for heterogeneity Cochran Q: 10.76, df: 5, p=0.06, I²: 54%)
Figure 7

Meta analysis of Length of stay: (a) C versus SR; (b) S versus SR; (c) DE versus SR

**Legend:** Each study is shown by the point estimate of the odds ratio/mean difference (OR/MD; square proportional to the weight of each study) and 95% confidence interval (CI) for the OR (extending lines); the combined ORs/mean difference and 95% CIs by random effects calculations are shown by diamonds.

(a) C versus SR and length of stay (n=1067, p=0.002; test for heterogeneity Cochran Q: 29.19, df: 5, p<0.0001, I²: 83%)

(b) S versus SR and length of stay (n=525, p=0.19; test for heterogeneity Cochran Q: 21.25, df: 2, p<0.0001, I²: 91%)

(c) DE versus SR and length of stay (n=445, p=0.002; test for heterogeneity Cochran Q: 10.64, df: 4, p=0.03, I²: 62%)
Figure 8

Meta analysis of stoma requirement: (a) C versus SR; (b) S versus SR; (c) DE versus SR

Legend: Each study is shown by the point estimate of the odds ratio/mean difference (OR/MD; square proportional to the weight of each study) and 95% confidence interval (CI) for the OR (extending lines); the combined ORs/mean difference and 95% CIs by random effects calculations are shown by diamonds.

(a) C versus SR and stoma requirement (n=2483, p=0.002; test for heterogeneity Cochran Q: 117.82, df = 4, p<0.00001, I²: 90%)

(b) S versus SR and stoma requirement (n=924, p=0.00001; test for heterogeneity Cochran Q: 4.42, df = 4, p=0.35, I²: 9%)

(c) DE versus SR and stoma requirement (n=1674, p=0.21; test for heterogeneity Cochran Q: 54.05, df = 9, p=0.00001, I²: 83%)
Figure 9

Meta analysis of leak rate: (a) C versus SR; (b) S versus SR; (c) DE versus SR

Legend: Each study is shown by the point estimate of the odds ratio/mean difference (OR/MD; square proportional to the weight of each study) and 95% confidence interval (CI) for the OR (extending lines); the combined ORs/mean difference and 95% CIs by random effects calculations are shown by diamonds.

(a) C versus SR and leak rate (n=1129, p=0.22; test for heterogeneity Cochran Q: 2.26, df: 8, p=0.97, I^2: 0%)

(b) S versus SR and leak rate (n=237, p=0.59; test for heterogeneity Cochran Q: 0.01, df: 1, p=0.93, I^2: 0%)

(c) DE versus SR and leak rate (n=777, p=0.37; test for heterogeneity Cochran Q: 2.30, df: 6, p=0.89, I^2: 0%)
Figure 10

Meta analysis of pelvic abscesses: (a) C versus SR; (b) S versus SR; (c) DE versus SR

Legend: Each study is shown by the point estimate of the odds ratio/mean difference (OR/MD; square proportional to the weight of each study) and 95% confidence interval (CI) for the OR (extending lines); the combined ORs/mean difference and 95% CIs by random effects calculations are shown by diamonds.

(a) C versus SR and pelvic abscesses (n=1825, \( p = 0.18 \); test for heterogeneity Cochran Q: 9.86, df: 9, \( p = 0.36 \), \( I^2 = 9\% \))

(b) S versus SR and pelvic abscesses (n=432, \( p = 0.13 \); test for heterogeneity Cochran Q: 0.63, df: 2, \( p = 0.73 \), \( I^2 = 0\% \))

(c) DE versus SR and pelvic abscesses (n=1270, \( p = 0.60 \); test for heterogeneity Cochran Q: 9.32, df: 6, \( p = 0.16 \), \( I^2 = 36\% \))
Figure 11

Meta analysis of rectovaginal fistula: (a) C versus SR; (b) S versus SR; (c) DE versus SR

Legend: Each study is shown by the point estimate of the odds ratio/mean difference (OR/MD; square proportional to the weight of each study) and 95% confidence interval (CI) for the OR (extending lines); the combined ORs/mean difference and 95% CIs by random effects calculations are shown by diamonds.

(a) C versus SR and rectovaginal fistula (n=1503, p=0.92; test for heterogeneity Cochran Q: 9.02, df: 7, p=0.25, I²: 22%)
(b) S versus SR and rectovaginal fistula (n=361, p=0.07; test for heterogeneity Cochran Q: 0.08, df: 1, p=0.77, I²: 0%)
(c) DE versus SR and rectovaginal fistula (n=1190 p=0.61; test for heterogeneity Cochran Q: 4.09, df: 5, p=0.54, I²: 0%)
Figure 12

Meta analysis of rectal stenosis: (a) C versus SR; (b) S versus SR; (c) DE versus SR

Legend: Each study is shown by the point estimate of the odds ratio/mean difference (OR/MD; square proportional to the weight of each study) and 95% confidence interval (CI) for the OR (extending lines); the combined ORs/mean difference and 95% CIs by random effects calculations are shown by diamonds.

(a) C versus SR and rectal stenosis (n=2083, p=0.009; test for heterogeneity Cochran Q: 11.35, df: 9 (I² = 21%)
(b) S versus SR and rectal stenosis (n=714, p=0.01; test for heterogeneity Cochran Q: 0.10, df: 1 (I² = 0%)
(c) DE versus SR and rectal stenosis (n=1278, p=0.35; test for heterogeneity Cochran Q: 11.46, df: 6, p=0.08, I²: 48%)
Figure 13

Meta analysis of rectal recurrence: (a) C versus SR; (b) S versus SR; (c) DE versus SR

Legend: Each study is shown by the point estimate of the odds ratio/mean difference (OR/MD; square proportional to the weight of each study) and 95% confidence interval (CI) for the OR (extending lines); the combined ORs/mean difference and 95% CIs by random effects calculations are shown by diamonds.

(a) C versus SR and rectal recurrence (n=698, p=0.002; test for heterogeneity Cochran Q: 0.25, df: 3, p=0.97, I²: 0%)

(b) S versus SR and rectal recurrence (n=630, p=0.0007; test for heterogeneity Cochran Q: 0.32, df: 3, p=0.96, I²: 0%)

(c) DE versus SR and rectal recurrence (n=236, p=0.13; test for heterogeneity Cochran Q: 0.29, df: 2, p=0.87, I²: 0%)
Figure 14

Meta analysis of LARS: (a) minor LARS; (b) major LARS

**Legend:** Each study is shown by the point estimate of the odds ratio/mean difference (OR/MD; square proportional to the weight of each study) and 95% confidence interval (CI) for the OR (extending lines); the combined ORs/mean difference and 95% CIs by random effects calculations are shown by diamonds.

(a) C versus SR and minor LARS (n=511, p=0.30; test for heterogeneity Cochran Q: 2.86, df: 2, p=0.24, I²: 30%)

(b) C versus SR and major LARS (n=511, p=0.54; test for heterogeneity Cochran Q: 3.01, df: 2, p=0.22, I²: 33%)