



OPEN Comparative pregnancy rate after colorectal resection versus other surgical procedures for deep infiltrating rectal endometriosis: a systematic review and meta-analysis

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The debate around colorectal surgery for endometriosis has been ongoing, but to date no meta-analysis has investigated the impact of the different surgical approaches on the pregnancy rate. The aim of this meta-analysis study was to determine in women with deep infiltrating rectal endometriosis, how does colorectal resection surgery compare to other surgical techniques (e.g., rectal shaving, disc excision) in terms of pregnancy rates. We searched PubMed, Web of Science, Cochrane library and Clinical Trials for relevant studies published from inception to December 2024. We performed a systematic review and meta-analysis of all English language full-text articles addressing colorectal resection compared with other management of deep infiltrating rectal endometriosis and presenting pregnancy outcomes. We included a study when it (i) provided data on surgical management (shaving, disc excision, and/or colorectal resection) and (ii) detailed the pregnancy outcomes in each subgroup. Four authors independently performed the initial search to evaluate the eligibility criteria. Four authors extracted the data and a fifth author checked this extraction. Of the 113 full-text articles assessed for eligibility, we included 13 in the meta-analysis. These studies represented a total of 3,248 patients. Pregnancy information was available for 2,131 patients: 1073 colorectal resection, 502 shaving, 172 disc excisions, and 384 other practices (expectant management). Colorectal resection was associated with a lower pregnancy rate compared with the other techniques ($N = 2,131$, odds ratio [OR] = 0.64 [95% confidence interval 0.52–0.79], $p < 0.001$, $I^2 = 35\%$). There were similar results when comparing colorectal resection with rectal shaving ($N = 952$, OR = 0.51 [95% confidence interval 0.36–0.73], $p < 0.001$, $I^2 = 0\%$), but not when comparing colorectal resection with disc excision ($N = 432$, OR = 0.65 [95% confidence interval 0.37–1.13], $p = 0.13$). Conclusions Rectal resection for endometriosis is associated with a lower pregnancy rate compared with other type of surgery, such as shaving.

Trial registration: PROSPERO registration number CRD42024512328.

Keywords Endometriosis, Colorectal resection, Shaving, Disc excision, Pregnancy

Endometriosis, a common condition affecting the female reproductive system, affects approximately 5–10% of women during their reproductive years¹. This condition can manifest in the pelvic region in three distinct forms: superficial endometriosis affecting the peritoneum, ovarian endometriosis (endometriomas), and deep

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infiltrating endometriosis (DIE), which may involve various locations, such as the rectovaginal area². DIE lesions in the rectovaginal area typically originate at the posterior cervix and progressively involve the anterior portion of the rectum³.

In cases of DIE, disrupted anatomy and severe intra-abdominal adhesions interfere with gamete transport. Even women with minimal or mild endometriosis, who do not have adhesions, experience reduced fertility. This decline in fertility appears to be linked to disruptions in ovulation, fertilization, implantation, and an increased risk of miscarriage⁴. Patients with endometriosis undergoing in vitro fertilization (IVF) treatments face lower rates of fertilization, implantation, and pregnancy compared to women without the condition. The outcomes are particularly poor for those with advanced disease, with DIE specifically negatively impacting IVF and intracytoplasmic sperm injection (ICSI) results⁵.

For patients with mild to minimal endometriosis, surgical treatment offers benefits with a low complication rate. However, the situation is more complex for those with advanced disease due to limited evidence and the potential for severe complications. Reduced fertility remains a significant issue for women with endometriosis. The effect of surgeries for DIE, particularly those involving the bowel wall, on fertility remains a controversial topic, with diverse opinions reflected in the literature⁶.

Medical interventions can alleviate the symptoms of rectovaginal DIE, but they do not eliminate the disease and are frequently accompanied by side effects such as irregular bleeding, weight changes, reduced sexual desire, and headaches⁷. Additionally, pregnancy does not halt the progression of the disease⁸. Surgical excision of rectovaginal DIE, however, has been shown to improve fertility prospects⁹. Rectovaginal DIE in pregnant women has been associated with increased risks of preterm birth, hospital admissions, and low birth weight in newborns¹⁰.

When rectovaginal DIE lesions involving the rectum cause symptoms that adversely affect pain, bowel, sexual, or reproductive functions, despite optimized medical treatment, surgical removal may be considered. Various surgical approaches—including laparoscopic bowel resection, disc excision, and rectal shaving—are utilized, but there is no consensus on the optimal surgical technique or timing for these interventions. Criteria for bowel resection, such as infiltration of the rectal mucosa or invasion involving more than half of the bowel's circumference, have been proposed⁹. However, these criteria and the decision-making process for surgery in cases of rectovaginal DIE remain subjects of ongoing debate^{9,11}.

Some studies have suggested that colorectal surgery aimed solely at improving reproductive outcomes in infertile patients with intestinal endometriosis should be performed only in research settings and by highly experienced surgeons¹². Women should be informed about the uncertainties regarding the risks and benefits of bowel surgery in various clinical scenarios. Preoperative counselling must be conducted impartially, with the goal of fostering a shared medical decision-making process.

The lack of consensus regarding the optimal surgical management of DIE contributes to these discordant findings^{9,13}. Furthermore, no meta-analysis has yet investigated the impact of different surgical techniques on pregnancy rates.

This meta-analysis study aims to evaluate how colorectal resection surgery compares to other surgical techniques (e.g., rectal shaving, disc excision) in terms of pregnancy rates in women with deep infiltrating rectal endometriosis.

Methods

We performed a systematic review and meta-analysis by following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines¹⁴, and in line with the suggestions provided by the Cochrane Collaboration¹⁵. PROSPERO registration number: CRD42024512328.

Eligibility criteria

Included studies were cross-sectional, nonrandomized and randomized clinical trials, case-controls, while excluded studies were case-reports, general reviews, systematic reviews and studies with no control group.

Information sources

We searched PubMed, Web of Science, Cochrane Library and Clinical Trials for relevant studies published from inception to December 2024.

Search strategy

The search strategy consisted of specific vocabulary and the National Library of Medicine's Medical Subject Headings (MeSH) terms. We used the following search string: ((“infertility” OR “fertility” OR “reproductive”) OR (“in vitro” AND (fertilization OR “IVF” OR “assisted reproduction”))) AND ((colorectal AND (“endometriosis” OR endometriosis)) OR ((deep AND infiltrating AND (“endometriosis” OR endometriosis))) OR (“deep infiltrative endometriosis” OR (“intestinal” OR “bowel” OR “rectovaginal” OR “vaginal”)) AND (“endometriosis”))). We only considered English-language studies and we performed a thorough assessment of the references from the pertinent articles.

Selection and data collection process

Four authors (PFC, SH, RM, and MC) independently conducted the initial search to evaluate studies based on the eligibility criteria. Data extraction was performed by the same four authors (PFC, SH, RM, and MC), while the remaining author (JMA) reviewed and verified the extracted data.

Studies were included if they met the following criteria: (i) they provided data on surgical management techniques (shaving, disc excision, and/or colorectal resection), and (ii) they detailed pregnancy outcomes in each subgroup, including spontaneous pregnancy and/or assisted reproductive technology (ART).

The quality of each included study was independently assessed by four authors (PFC, SH, RM, and MC). Discrepancies in assessments were discussed among these authors, and if consensus could not be reached, a fifth reviewer (JMA) was consulted.

Data items

We extracted and summarized the following data: author, year of publication, country, number of patients, type of study, surgical approach, surgical technique, period of inclusion, main outcome (pregnancy rate), modality of diagnosis, preoperative medical therapy, major complications, duration of infertility and follow-up duration.

Effect measures

We assessed the pregnancy rate (number and percentage) in each group of patients. When data were available allowing the comparison for pregnancy rate, we performed a fixed-effects meta-analysis. We assessed the number, percentage, mean, standard deviation, median, interquartile range, and confidence interval (CI) for all measures of each study¹⁶.

Synthesis methods

Odds ratios (ORs) and 95% confidence intervals (CIs) for dichotomous outcomes were calculated, with statistical significance defined as $p < 0.05$. Statistical heterogeneity was evaluated using Cochran's Q test and the I^2 statistic, where an I^2 value below 50% was indicative of low heterogeneity. In the absence of significant heterogeneity, a fixed-effects model was employed; otherwise, a random-effects model was utilized for pooled estimates. All statistical analyses were conducted using SAS software.

Risk of bias

During the data extraction process, researchers independently assessed the risk of bias for each study using the ROBINS-I tool (Risk Of Bias In Non-randomized Studies - of Interventions)¹⁷. The evaluation criteria included: Bias due to confounding, Bias in selection of participants into the study, Bias in classification of interventions, Bias due to deviations from intended interventions, Bias due to missing data, Bias in measurement of outcomes, Bias in selection of the reported results. We generated funnel plots to evaluate publication bias. We rated risk of bias for each criterion as low, moderate or high.

Results

Study selection and study characteristics

We included 13 studies in the systematic review and meta-analysis (Fig. 1). Six studies were prospective^{7,18–22}, two were randomized trials^{23,24}, and five were retrospective^{25–29}. The 13 included studies enrolled a total of 3,248 patients. There was pregnancy information for 2,131 patients: 1073 who underwent colorectal resection, 502 who underwent shaving, 172 who underwent disc excision, and 384 who underwent other practices (expectant management). Tables 1, 2 and 3 summarize the characteristics, outcomes, and postoperative outcomes of the 13 studies included in the review^{7,18–29}. Eleven studies were conducted in Europe, in France^{21,23,25,27,28}, Italy^{19,24,26}, Finland²⁹, Austria¹⁸, and Belgium²⁰. One study²² was conducted in the USA and one study¹⁹ was conducted in Iran.

Surgical procedures

Shaving is the least invasive procedure, consisting of a layer-by-layer excision of the rectal lesion, without full-thickness resection. Shaving is used in cases where the lesion has partially invaded the muscular layers, but not the full thickness of the bowel wall⁹.

Disc excision consists of full-thickness excision of the rectal lesion on the bowel wall with opening of the mucosa and a transverse repair⁹.

Anterior resectosigmoid segmental resection with end-to-end anastomosis is performed in cases of full-thickness large or multiple rectal lesions. It may or may not be protected by an ileostomy⁹.

In five studies^{22,24–27}, the surgical procedures were laparoscopic, and in two studies^{7,20} the surgery was laparotomic. One study did not provide this information, and the other studies^{18,19,23,28,29} presented different rates of both types of surgery, including conversion to laparotomy.

Rectal shaving and disc excision definitions

There are different definitions for these surgeries¹³. Only three studies provided a clear definition of these types of surgery: Abo et al.²⁷ defined shaving as nodule excision without opening the rectum and disc excision as resection of the nodule with excision of the anterior rectal wall. Bourdel et al.²⁸ defined shaving as a “reverse technique” starting from the lateral and the vaginal parts of the nodule and ending with rectal invasion. Mohr et al.²² defined shaving as the least invasive procedure, consisting of layer-by-layer combined carbon dioxide (CO₂) laser vaporisation and excision of the lesion, without full-thickness resection; they defined disc excision as full-thickness excision of the lesion on the bowel wall with transverse repair.

Meta-analysis

Colorectal resection was associated with a lower pregnancy rate compared with other techniques ($N = 2,131$, 35.5% vs. 42.6%, OR = 0.64 [95% CI 0.52–0.79], $p < 0.001$, $I^2 = 35\%$)^{7,18–29} (Fig. 2). There was a similar result when comparing colorectal resection with shaving ($N = 952$, 17.3% vs. 38.8%, OR = 0.51 [95% CI 0.36–0.73], $p < 0.001$, $I^2 = 0\%$)^{19,21,22,25–28} (Fig. 3), but not when comparing colorectal resection with disc excision ($N = 432$, 29.2% vs. 35.8%, OR = 0.65 [95% CI 0.37–1.13], $p = 0.13$)^{18,19,21–23,27} (Fig. 4). The test of asymmetry funnel plots (Fig. 5) indicated publication bias among the included studies.

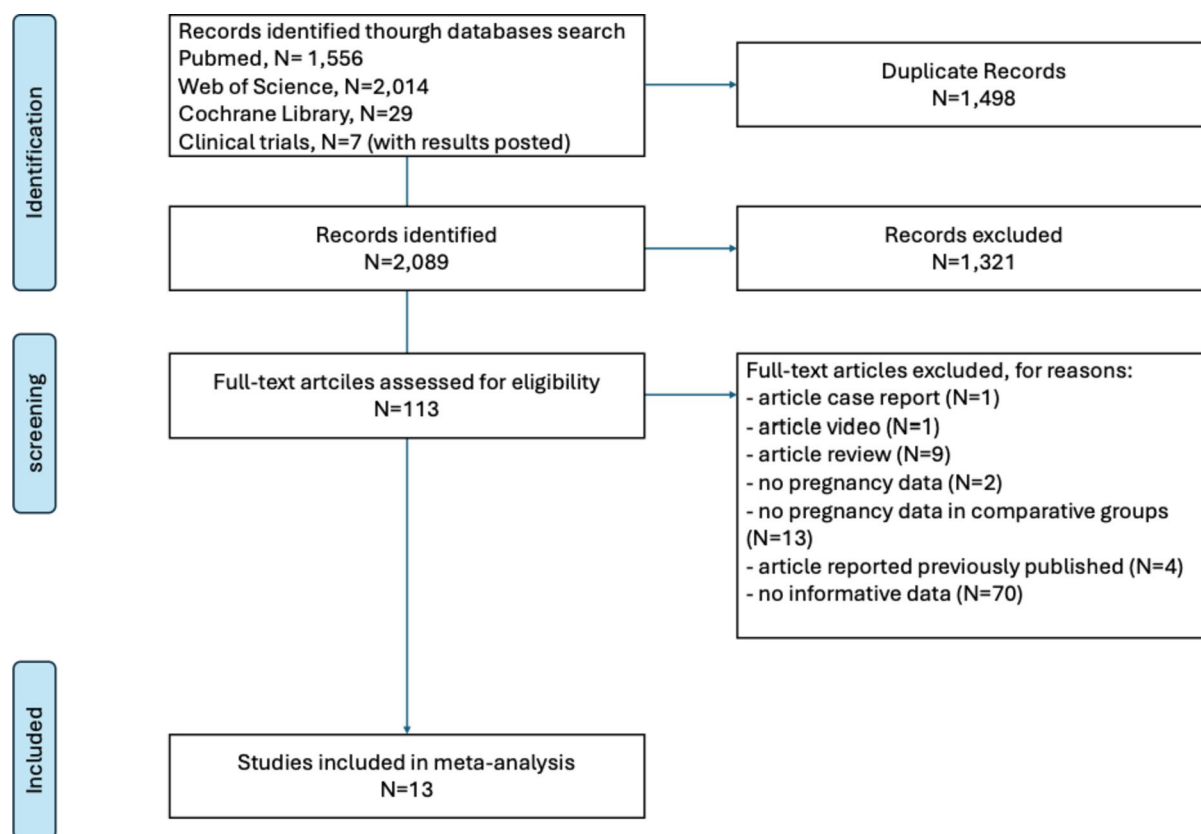


Fig. 1. Flowchart.

Spontaneous pregnancy rate

Six studies reported spontaneous pregnancy rate, and we observed no significant difference between colorectal resection and other techniques, $N=912$, 34.9% vs. 34.1%, (OR = 1.33 [0.97–1.83], $p=0.08$)^{18,20,25,26,28,29} (Fig. 6).

Risk of bias

Included studies presented moderate risk of bias for non-randomized studies according to the ROBINS-I tool risk of bias. Maggiore et al. presented unclear definition of disc excision, thus this study has been removed from the analysis of colorectal resection vs. disc excision. Risk of bias is shown in Table 4.

Discussion

We conducted a meta-analysis focusing on pregnancy rates following surgery for deep infiltrating endometriosis (DIE) affecting the rectum. Our findings indicate that colorectal resection is associated with a lower pregnancy rate compared to other surgical techniques, including rectal shaving and disc excision.

The debate surrounding colorectal surgery for endometriosis persists, primarily due to concerns about the associated risks. Recent studies, including meta-analyses, have highlighted that this type of surgery can result in severe complications such as rectovaginal fistula, anastomotic leakage, anastomotic stenosis, and voiding dysfunction. In contrast, rectal shaving has been shown to have a lower risk of postoperative complications compared to other surgical techniques like disc excision and segmental colorectal resection^{9,13,30}. Despite these findings, no prior study has reached a definitive conclusion regarding the differences in pregnancy rates between these surgical methods.

Endometriosis can negatively affect both natural and assisted conception. Mechanisms proposed to explain its impact on reproductive dysfunction include impaired folliculogenesis leading to follicular dysfunction and reduced egg quality, luteal phase abnormalities, decreased fertilization rates, and abnormal embryogenesis^{31,32}.

In addition to its effects on conception, endometriosis can also influence obstetric and neonatal outcomes of pregnancy. These include an increased risk of small-for-gestational-age infants, caesarean section, miscarriage, hemorrhage, low placental adhesion, and preterm delivery^{33,34}.

During pregnancy, hormonal changes may alter endometriotic lesions, leading to atypical appearances that pose a clinical dilemma. Managing these events is challenging due to the limited number of reported cases. A review of the available literature highlights the lack of formal estimates of their incidence. While complications of endometriosis during pregnancy are rare, there is no evidence to suggest that the disease has a significant detrimental effect on pregnancy outcomes.

Endometriosis can negatively impact both natural and assisted conception processes³⁵. Proposed mechanisms, including impaired folliculogenesis resulting in follicular dysfunction and poor egg quality, as well as luteal

Study Year	Country	Study design	Period	Main outcome	Modality of diagnosis for colopathology	Modality of diagnosis for endometriosis	Patients	Preoperative medication	Surgical approach	Surgical techniques	Complications	Duration of infertility	Follow up
Hudelist, 2018	Austria	Prospective study	2011 to 2016	Yes, short- and long-term outcomes regarding perioperative morbidity, long-term pain and fertility outcomes	Not reported	TVS	134	Not reported	Laparoscopy (except one)	Segmental resection, disk excision	The rate of minor complications (Clavien-Dindo grade I and II) was 8.8% for the segmental resection (SR) group and 12.5% for the disk resection (DR) group. Major complications (grade III) occurred in seven of 102 women (6.9%) in the SR group and in one of 32 women (3.1%) in the DR group.	Not reported	34 to 36 months
Roman, 2022	France	Randomized trial	2011 to 2013	Not one of the following symptoms: constipation, frequent bowel movements, anal incontinence, or bladder dysfunction 24 months after surgery	Not reported	Pelvic magnetic resonance imaging (MRI)	55	Not reported	Laparoscopy; N = 51; Conversion to open route, N = 4.	Segmental resection, shaving or disk excision	Among colorectal resection, N = 28: 2 pelvic abscess or hematoma, 2 s laparoscopy, 1 transitory self-catheterization of the bladder; among excision group N = 27, 1 rectovaginal fistula, 1 bladder fistula secondary bladder resection and 6 transitory self-catheterization of the bladder	Not reported	84 months
Lapointe, 2022	France	Retrospective study	2009 to 2016	Yes, pregnancy rate after surgery	Clinical assessment before and during surgery.	Clinical and symptoms	94	none	Laparoscopy	Colorectal resection, shaving	In the shaving group (n = 55), 6 (10.9%) patients presented with complications (Dindo Clavien grade II or higher) 0.4 patients presented grade II complications: 3 had difficulty weaning from the urinary catheter and 1 patient required two red blood cell pellets transfusion. 2 patients presented grade IIIb complications: one ureteral wound with fistula and one hemoperitoneum. In the resection group (n = 39), 5 (12.8%) patients presented complications: 3 patients presented grade II complications: 3 had difficulties in weaning from the urinary catheter and one of them also required transfusion of two red blood cell pellets, 1 patient presented a large hemoperitoneum classified IIIb and 1 had a per-operative car-diac arrest classified IVb.	12.5 months	24 months
Maggiore, 2017	Italy	Retrospective study	2009 to 2015	Yes, Crude and cumulative SPR (spontaneous pregnancy rate)	Not reported	Transvaginal trasonography (TVS)	505	None	Laparoscopy	Segmental colorectal resection, shaving, disk excision	Not reported	12 months	12 months
Abo, 2018	France	Retrospective study	2009 to 2015	Not, complications related to surgeries	Not reported	Not reported	364	None	Laparoscopy	Segmental colorectal resection, shaving, disk excision	The mean rate of Clavien 3b postoperative complications was 11.8%, representing 43 patients, among whom more than half (29 patients) were in the segmental colorectal resection arm (P1 < 0.001). Eight cases of stenosis of colorectal anastomosis (5.8%) were recorded in the segmental colorectal resection arm (P1 = 0.003), six of which were managed by endoscopic dilation and two by secondary colorectal resection.	Not reported	36 months
Continued													

Study Year	Country	Study design	Period	Main outcome	Modality of diagnosis for colopathology	Modality of diagnosis for endometriosis	Patients	Preoperative medication	Surgical approach	Surgical techniques	Complications	Duration of infertility	Follow up
Alborzi, 2022	Iran	Prospective study	2015 to 2021	Yes, short and long term outcomes (including fertility)	Endometriosis-related pain symptoms	Colorectal endometriosis using imaging techniques and clinical symptoms	837	Not reported	Laparoscopy (28–37% of the surgeries) and laparotomy	Segmental colorectal resection, shaving, disk excision	Fever and the need for blood transfusion, peritonitis and rectovaginal fistula were higher in segmental group than in shaving group. Abscess, external iliac artery injury, early and late bladder atony, and DVT, were seen in 2.7% of the patients and only in the segmental group.	11 to 14 months	12 months
Bourdel, 2018	France	Retrospective study	2000 to 2013	Yes, pain and fertility	Invasion of rectum layers was further assessed using magnetic resonance imaging (MRI) and/or vaginal or rectal ultrasound	Not reported	195	Not reported	Laparoscopy (98.6%) and conversion	Segmental colorectal resection, shaving	The rate of minor complications (grade I and II) was 13% for the SG and 30% for the RG (RR = 2.83; 95% CI 1.01–7.63; $p = 0.05$). Major complications (grade III) occurred in seven patients (4%) in the SG and in six patients (26%) in the RG (RR = 6.55; 95% CI 1.88–22.8; $p = 0.001$).	Not reported	60 to 67 months
Meuleman, 2014	Belgium	Prospective study	2006 to 2008	Not, clinical outcomes	Not reported	Vaginal examination, TVUS, bowel barium enema	203	GnRH analog therapy 3 months before surgery	Laparotomy	Colorectal resection, other surgery	The prevalence of Clavien-Dindo grade III or higher ("major") postoperative complications was 2% overall ($n = 4/203$) and was similar for the study (3%; $n = 2/76$) and control (2%; $n = 2/127$) groups. The prevalence of Clavien-Dindo grade I to II ("minor") complications was 4% overall ($n = 9/203$) and was higher in the study group (11%; $n = 8/76$) than in the control (1%; $n = 1/127$) group ($p = 0.002$).	Not reported	24 months
Stepniowska, 2009	Italy	Randomized trial	2000 to 2005	Yes, infertility questionnaire	Double contrast barium enema	Not reported	155	Not reported	Laparoscopy	Segmental colorectal resection, and no segmental resection	The main surgical complications which occurred in group colorectal resection were two anastomotic fistulas (3.2%), both after a very low bowel resection. The other early (before a month after surgery) post-operative complications in group colorectal resection were: ureteral lesion (1.6%), bladder lesion (1.6%), bowel occlusion (1.6%) or severe blood loss (12.8%) treated by hemotransfusion (6.4%) or autotransfusion (6.4%).	30 months	27 months
Continued													

Study Year	Country	Study design	Period	Main outcome	Modality of diagnosis for colopathology	Modality of diagnosis for endometriosis	Patients	Preoperative medication	Surgical approach	Surgical techniques	Complications	Duration of infertility	Follow up
Tuominen, 2021	Finland	Retrospective study	2004 to 2013	Yes, long-term pregnancy and delivery outcomes	Clinical examination with typical findings, transvaginal ultrasound, or magnetic resonance	Clinical examination, transvaginal ultrasound, or magnetic resonance	543	In conservative group: combined oral contraceptive pills, progestin-only pills, levonorgestrel-releasing intrauterine system, and gonadotropin-releasing hormone analogues with or without add-back as oral contraceptives or estrogen are used.	Laparoscopy and laparotomy	Operative and conservative	Grade III–IV surgical complications were experienced by 22 (6.1%) women in the operative group, and four of the 35 women (11.4%) who underwent surgery later in the conservative group.	Not reported	60 months
Vercellini, 2006	Italy	Prospective study	Not reported	Yes, incidence of pregnancy	Vaginal and rectal examinations performed, transvaginal and transrectal ultrasonography, and histologic demonstration of endometriosis in a biopsy of the posterior fornix	TVUS, TRUS, clinical examinations	105	None	Laparotomy	Colorectal resection, expectant management	One major and 9 minor postoperative complications occurred.	23 to 25 months	27 months
Continued													

Study Year	Country	Study design	Period	Main outcome	Modality of diagnosis for colopathology	Modality of diagnosis for endometriosis	Patients	Preoperative medication	Surgical approach	Surgical techniques	Complications	Duration of infertility	Follow up
Mohr 2005	USA	Retrospective study	1990 to 1997	Yes, complications and fertility rates	Histologically or clinically, or both histologically and clinically modalities	Not reported	178	Not reported	Laparoscopy	Segmental colorectal resection, shaving, disk excision	Complications included 24 minor and 9 major ones for combined complication rates across all procedures of 13% and 5%, respectively. Four patients (3%) required an additional surgical procedure to address a complication. The least invasive procedure, shaving, had a significantly lower overall complication rate (6%) compared with 23% for disk excision ($P < 0.007$) and 38% for segmental resection ($P < 0.001$).	Not reported	24 months
Breteau 2019	France	Retrospective study	2009 to 2016	Yes, overall pregnancy rate	MRI examinations and confirmed by positive histological results + transvaginal and rectal ultrasound, or computed tomography-based virtual colonoscopy.	Not reported	71	Hormonal treatment to relieve pain symptoms (e.g., GnRH analogues, progestins, or contraceptive pill)	Not reported	Segmental colorectal resection, shaving, disk excision	Not reported	Not reported	12 months

Table 1. Study characteristics. DR: Disk resection is used to remove localized nodules or lesions of endometriosis that have infiltrated the bowel wall but do not require the removal of an entire segment of the bowel. SR: Segmental resection is employed to remove larger and deeper lesions of endometriosis that infiltrate multiple layers of the bowel wall. Shaving: The shaving procedure aims to remove superficial endometriotic lesions from the surface of organs, such as the bowel, bladder, or other pelvic structures, while preserving the underlying tissue. NR: Not Reported

phase abnormalities, reduced fertilization rates, and abnormal embryogenesis, help to explain the reproductive challenges associated with the condition³².

Additionally, endometriosis may affect obstetric and neonatal outcomes, contributing to complications such as small-for-gestational-age infants, an increased rate of caesarean sections, miscarriages, hemorrhages, low placental adhesion, and preterm deliveries³⁶.

During pregnancy, hormonal changes can alter endometriotic lesions, which may appear atypical and present a clinical challenge. Managing these conditions is difficult due to the limited number of documented cases, and a review of the literature reveals a lack of formal incidence estimates. Despite these challenges, complications arising from endometriosis during pregnancy are uncommon, and there is no significant evidence indicating that the condition substantially worsens pregnancy outcomes^{37,38}.

The observed lower pregnancy rate associated with colorectal resection compared to rectal shaving and disc excision in cases of endometriosis may be attributed to several factors. A study comparing the laparoscopic surgical management of bowel endometriosis using three techniques—shaving, discoid excision, and colorectal resection—revealed that all methods were effective for immediate symptom relief. However, the shaving group experienced significantly higher rates of symptom recurrence and the need for reintervention. This suggests that while the less invasive shaving technique provides initial relief, it may not offer as durable a resolution as the more invasive segmental resection. Notably, that study did not directly compare pregnancy rates among the techniques³⁹.

The choice of surgical method is influenced by factors such as the size and location of endometriotic nodules, the patient's fertility desires, and the risk of complications. Conservative techniques like shaving, which preserve more of the bowel, may reduce complication rates but might not completely remove all endometriotic tissue, potentially leading to higher recurrence rates. In contrast, more invasive procedures like segmental resection may achieve more thorough removal of endometriotic tissue but carry a higher risk of complications due to their invasiveness.

This meta-analysis provides valuable insights into the impact of rectal resection on fertility. The decision regarding surgical technique should be tailored to each patient's unique case and fertility goals. Lapointe et al. (2022) evaluated postoperative fertility and pregnancy outcomes in patients with colorectal DIE, comparing outcomes between those undergoing shaving and those undergoing digestive resection (discoid or segmental). The study included 94 patients, with 39 undergoing bowel resection and 55 undergoing shaving. While no significant difference was found in the overall pregnancy rate between the two groups, there was a higher rate of spontaneous pregnancies in the resection group²⁵.

However, our meta-analysis found no significant association between resection surgery and spontaneous pregnancy. This suggests that resection surgery may not confer a greater advantage for spontaneous pregnancy occurrence compared to overall pregnancy outcomes.

Several physiological pathways may explain the lower pregnancy rate observed with colorectal resection compared to shaving and disc resection in women with endometriosis. Colorectal resection is a more extensive and invasive procedure, often involving the removal of a portion of the bowel. This can lead to significant alterations in pelvic anatomy, potentially affecting adjacent organs such as the uterus and fallopian tubes, thereby impacting fertility⁴⁰.

More invasive surgeries, like colorectal resection, are associated with increased post-surgical adhesions (scar tissue formation). These adhesions can impair the normal functioning of reproductive organs by obstructing the fallopian tubes or altering the uterine environment, which may reduce fertility⁴¹. Additionally, invasive procedures can indirectly affect ovarian reserve. Any surgery performed in the pelvic area carries the risk of disrupting the blood supply to the ovaries or causing inadvertent damage, potentially reducing the number of viable eggs available for fertilization⁴².

Major surgeries also trigger a heightened immune and inflammatory response. This increased inflammatory environment in the pelvis following surgery could adversely impact implantation and early embryonic development⁵. Furthermore, colorectal resection carries a higher risk of nerve damage or alterations in pelvic innervation⁴⁰. Such changes can affect uterine and tubal function, as well as overall pelvic health, which are critical for successful conception and pregnancy.

The severity of pain symptoms plays a pivotal role in the decision-making process for the surgical treatment of endometriosis, significantly impacting both pain relief and fertility outcomes. Studies indicate that patients experiencing severe pain symptoms, such as dysmenorrhea, dyspareunia, and dyschezia, are more likely to pursue surgical interventions, which can result in substantial pain relief and an improved quality of life^{7,24}.

A shared decision-making approach, involving thorough discussions about the risks and benefits of surgery versus expectant management, is essential to ensure that treatment decisions align with the patient's preferences and clinical indications. Consequently, a comprehensive evaluation of pain symptoms is critical for developing individualized treatment plans that effectively address pain management while optimizing reproductive health.

The strength of this meta-analysis lies in its novelty, as it appears to be the first to compare pregnancy rates across different surgical approaches for endometriosis. However, several limitations warrant attention. According to the Cochrane guidelines, assessing the risk of bias is typically required. However, given that our systematic review included only two randomized controlled trials, we deemed it inappropriate to conduct a risk of bias evaluation.

Additionally, the heterogeneity observed among some studies may impact the precision and reliability of the findings. Variability in how results were reported across studies further complicated the meta-analysis of other criteria, limiting its overall feasibility. The heterogeneity in the stages of endometriosis presented a significant limitation, particularly when comparing surgical types and pregnancy outcomes for different levels of deep infiltrative endometriosis.

Reference	Characteristics of patients included	Symptoms	Dyspareunia	Dysmenorrhea	Rectorrragy ? Dyschezia ?	Urinary symptoms	Adenomyosis	Extensions (pelvic organs ...)
Hudelist, 2018	102 patients (SR), 32 patients (DR) Mean age: 34.5 years (SR), 34.0 years (DR), Infertility: 58.9% (SR), 37.5% (DR)	Chronic pelvic pain	68.6% (SR), 84.4% (DR)	100% (both groups)	Dyschezia: 65.7% (SR), 50% (DR)	Dysuria: 12.7% (SR), 12.5% (DR)	NR	Vagina: 83.3% (SR), 87.5% (DR), Parametrium: 82.4% (SR), 96.9% (DR), Rectum/Sigmoid: 100% (both groups)
Roman, 2022	55 patients with deep endometriosis infiltrating the rectum Mean age: 30 years (shaving/DR), 28 years (SR), Nullipara: 74.1% (shaving/DR), 71.4% (SR)	Constipation, frequent bowel movements, anal incontinence, bladder dysfunction	74.1% (shaving/DR), 85.7% (SR)	100% (both groups)	Pain during defecation: 77.8% (shaving/DR), 78.6% (SR)	29.6% (shaving/DR), 25.0% (SR)	77.8% (shaving/DR), 60.7% (SR)	Endometrioma: 29.6% (shaving/DR), 46.4% (SR), Ureteral nodules 14.8% (shaving/DR), 10.7% (SR), Bladder nodule: 11.1% (shaving/DR), 3.6% (SR), Posterior vaginal fornix: 88.9% (shaving/DR), 71.4% (SR), Omentoplasty : 66.7% (shaving), 75% (SR)
Lapointe, 2022	55 patients (shaving), 39 patients (SR), Mean age: 30.7 years, Nulliparous: 92.5%, Infertility: 39.4%	NR	NR	NR	Dyschezia : 43.6% (shaving), 53.9% (SR) Rectorragy: 14.6% (shaving), 30.8% (SR) Diarrhea : 7.3% (shaving), 5.1% (SR)	NR	3.6% (shaving) 5.1% (SR)	100% stade 4 endometriosis. Not specifically detailed by organs.
Maggiore, 2017	Mean age : 33.1 y (No SR), 33.3 y (SR) Mean age: 33 years (both groups), Nulliparous: 100% (both groups)	Chronic pelvic pain, Infertility	6.3% (No SR), 9.5% (SR)	45.1% (No SR), 49.8% (SR)	Dyschezia: 41.5% (No SR), 46.2% (SR)	NR	Focal: 6.7% (No SR), 7.7% (SR), Diffuse: 16.9% (No SR), 19.0% (SR)	Rectovaginal nodule with/without ovarian endometrioma
Abo, 2018	145 patients (shaving), 80 patients (DR), 139 patients (SR) Mean age: 33 years, Nulliparous: 100%	Chronic pelvic pain	80% (shaving), 82.5% (DR), 69.8% (SR)	96.5% (shaving), 96.2% (DR), 96.4% (SR)	Dyschezia: 70.3% (shaving), 80% (DR), 70.5% (SR) Rectorrhage : 8.3% (shaving), 21.2% (DR), 21.6% (SR)	29.7% (shaving), 27.5% (DR), 23% (SR)	NR	Rectum: 100% (all groups) Rectosigmoid junction: 29.2% (shaving), 68.7% (DR), 66.9% (SR) Vagina: 6.9% (shaving), 42.5% (DR), 34.5% (SR) Diaphragm: 15.2% (shaving), 10% (DR), 24.5% (SR)
Alborzi, 2022	263 patients (shaving), 248 patients (DR), 326 patients (SR) Mean age: 34.1 y (shaving), 34.8 y (DR), 35.4 years (SR) Nulliparous: 100%	Chronic pelvic pain	77,08% (shaving), 92,59% (DR), 86,41% (SR)	77,36% (shaving) 84,48% (DR), 70,56% (SR)	Constipation : 10,7% (shaving), 10,7% (DR), 14,8% (SR) Dyschezia 84,62% (shaving), 100% (DR), 81,61 (SR)	NR	NR	Douglas pouch: 97%, bladder: 1.7%, Urters: 17.3%, External iliac artery: 0,11%, Nerve root: 0.45%.
Bourdel, 2018	172 patients (shaving), 23 patients (SR), Mean age: 31.5 y (shaving), 32.7 y (SR), Nulliparous: 100%	Chronic pelvic pain, infertility	60% (shaving), 65% (SR)	96.4% (shaving), 100% (SR)	Rectorragy: 94% (both groups), Dyschezia: 70% (shaving), 70% (SR)	NR	NR	Rectum: 100% (both groups) Vagina: 30% (SR) Uterosacral ligament: 68% (shaving), 67% (SR)
Meuleman, 2014	76 patients (SR), 127 patients (No SR) Mean age: 32.9 y (SR), 32.1 y (No SR)	Chronic pelvic pain: 56% (overall)	60% (SR), 51% (No SR)	90% (SR), 83% (No SR)	Dyschezia: 70% (SR), 46% (No SR), Cyclical rectal bleeding: 19% (SR), 6% (No SR)	Dysuria: 27% (SR), 15% (No SR) Hematuria 4% (SR), 3% (No SR)	NR	Nodules in Douglas pouch: 33% (SR), 14% (No SR), Nodules in rectovaginal septum: 18% (SR), 7% (No SR)
Stepniewska, 2009	– 60 patients (SR, group A), Mean age: 31.7 y, Nulliparous: 100% – 40 patients (No SR, residual bowel endometriosis, group B), Mean age: 33.5 years, Nulliparous: 100% – 55 patients (No SR, no bowel involvement, group C), Mean age: 32.4 y, Nulliparous: 100%	Chronic pelvic pain :52% (group A), 53% (group B), 35% (group C)	72% (group A) 65% (group B) 64% (group C)	98% (group A), 98% (group B), 65% (group C)	Dyschezia: 72% (group A), 33% (group B), 42% (group C) Rectorrhage: 8% (group A), 5% (group B), 0% (group C)	Dysuria: 20% (group A), 5% (group B), 9% (group C)	NR	Rectum: 100% (groups A, B), 0% (group C), Uterosacral ligament: 68% (group A), 67% (group B) Vagina: 15% (group A), 5% (group B), Parametrium: 5% (group A), 5% (group B) Endometrioma: 100% (group C)
Tuominen, 2021	Mean age SR: 31.9 years No SR: 31.5 years	Chronic pelvic pain: 64% (No SR), 95.8% (SR) Infertility: 47% (No SR), 34.4% (SR)	NR	NR	NR	NR	NR	NR
Continued								

Reference	Characteristics of patients included	Symptoms	Dyspareunia	Dysmenorrhea	Rectorragy ? Dyschezia ?	Urinary symptoms	Adenomyosis	Extensions (pelvic organs ...)
Vercellini, 2006	SR: 44 patients, Mean age: 32.7 years, BMI: 22.8, Primary infertility: 93.2%, Secondary infertility: 6.8% No SR: 61 patients, Mean age: 33.7 years, BMI: 22.4, Primary infertility: 91.8%, Secondary infertility: 8.2%	Chronic pelvic pain	52.3% (SR), 50.8% (No SR)	72.3% (SR), 75.4% (No SR)	Dyschezia: 38.6% (SR), 36.1% (No SR)	NR	NR	Pelvic extension or endometriomas excluded from the study.
Mohr 2005	100 patients (shaving), 39 patients (DR), 48 patients (SR), Mean age: 35 years, Nulliparous : 100%	Chronic pelvic pain	NR	98.9% (all groups)	Bowel symptoms: 74%, Constipation: 55%, Diarrhea: 41%, Rectorragy: 16%	NR	NR	Rectovaginal septum (54.3%), bladder nodule (1.8%), ureterolysis (45.2%), diaphragm (2.7%), presacral neurectomy (5.9%),
Breteau 2019	Pregnant group: 32 patients, Non-pregnant group: 41 patients, Mean age: 31.9 years, Mean duration of infertility: 48.4 months	NR	NR	NR	NR	NR	NR	Rectum (57.5%), sigmoid: 34.2%, Ileal (9.6%), appendix (9.6%), diaphragm (15.1%), vagina (37%), bladder (8.2%)

Table 2. Study characteristics with clinical information.

Furthermore, the inclusion criteria do not allow for a definitive conclusion that bowel resection results are inferior. This is because the indications for bowel resection were not consistently considered, and large lesions were less likely to be treated by bowel resection, especially since only two randomized clinical studies were included. Another key limitation is the lack of reporting on associated procedures, particularly those involving the treatment of ovarian endometriosis, as well as the number of patients who underwent IVF prior to surgery. These factors were not documented in the included studies, representing a significant limitation of this meta-analysis.

Conclusion

This systematic review and meta-analysis highlights that colorectal resection for deep infiltrating endometriosis is associated with a lower pregnancy rate compared to less invasive surgical approaches, such as rectal shaving. While colorectal resection may provide thorough removal of endometriotic tissue, its invasiveness is linked to potential disruptions in pelvic anatomy, increased adhesions, and other factors that could negatively impact fertility outcomes. However, the findings must be interpreted with caution due to significant limitations, including the heterogeneity of the included studies, variability in surgical indications, and the lack of consistent reporting on associated procedures, such as treatment for ovarian endometriosis or prior IVF. Furthermore, the inclusion of only two randomized clinical trials underscores the need for more robust research. Future studies, particularly randomized controlled trials, are essential to clarify the impact of different surgical techniques on fertility outcomes. Such research should aim to standardize reporting criteria and evaluate long-term reproductive health to provide clearer guidance for clinical decision-making. Until then, surgical approaches should be carefully tailored to individual patient profiles, considering both reproductive goals and the risks associated with more invasive procedures.

Reference	Surgical techniques	endometrioma	Preoperative characteristics of the digestive infiltration	Previous ovarian endometriosis surgery	Preoperative Infertile patients	Objectives of surgery (sub occlusive symptoms, worst cases of DIE or worst reproductive prognosis at baseline)	Additional surgery	Modality of conception (spontaneous vs. ART)	IVF before surgery	outcome pregnancy (spontaneous abortion, normal deliv. or c-sections)	Bias of the study
Huddell, 2018	SR N= 102 DR N= 32	Not reported	Enzian C Classification (rectum/sigmoid) : C1 SR 1.9%, DR 75% C2 SR 18.7%, DR 25% C3 SR 79.4%, DR 0%	Not reported	SR 58.9% DR 37.5%	Pain symptoms SR 41.3%, DR 62.5% Infertility SR 0.9%, DR 0% Pain symptoms and infertility SR 57.8% and DR 37.5%	ureterolysis SR 40.2%, DR 43.8% ureteral reimplantation SR 2%, DR 3% Endometrioma SR 37.3%, DR 27.5%	Spontaneous SR 40%, DR 54.5% IVF SR 24%, DR 9%	Not reported	Miscarriage: SR 15.6%, DR 14% Preterm birth: SR 12.5%, DR 14% Term delivery: SR 65.6%, DR 57.1%	
Roman, 2022	SR N= 28 Shaving N= 27	SR 29.6% Shaving 46.4%	Not reported	Not reported	SR 28.6% Shaving 37%	Not reported	endometrioma SR 46.4% Shaving 29% bladder nodule SR 3.5% Shaving 11.1% ureterolysis SR 10.7% Shaving 11.1% vaginal fornix SR 71.4% Shaving 88.8% appendicectomy SR 7.1% Shaving 14.8% omentoplasty SR 75% Shaving 66.7%	Spontaneous 57.4% IVF 42.5%	Not reported	Not reported	Monocentric study
Lapointe, 2022	SR N= 39 shaving N= 55	SR 38% shaving 27%	bowel infiltration SR 61% Shaving 42%	Not reported	Not reported	All patients with a pregnancy desire who underwent surgery for DIE involving the bowel	Not reported	Spontaneous 25.5% SR 35% Shaving 18% IVF 26%	shaving 23.6% SR 28%	Not reported	Monocentric retrospective study
Maggiore, 2017	SR N= 284 (group E), No surgery N= 221 (group S)	Unilateral SR 46.8% Np surgery 45.7% ; Bilateral SR 10.2% No surgery 10.5% No surgery 10.8%	Depth of infiltration of the bowel wall: Muscularis propria SR 10.2% No surgery 12.2% Submucosa SR 2.1% No surgery 2.7% Mucosa SR 1.4% No Surgery 0.9%	Not reported	Not reported live birth	Remove all the endometriosis lesions and to reduce the pain	Not reported	Cumulative Spontaneous Pregnancy Rates SR 23.8% No surgery 39.5%;	No	Not reported	Retrospective study Small sample size
Continued											

Reference	Surgical techniques	endometrioma	Preoperative characteristics of the digestive infiltration	Previous ovarian endometriosis surgery	Preoperative Infertile patients	Objectives of surgery (sub occlusive symptoms, worst cases of DIE or worst reproductive prognosis at baseline)	Additional surgery	Modality of conception (spontaneous vs. ART)	IVF before surgery	outcome pregnancy (spontaneous abortion, normal deliv. or c-sections)	Bias of the study
Abo, 2018	SR N= 139 DR N= 80 Shaving N= 145	SR 61.9% DR 43.7% Shaving 16.5%	Not reported	Not reported	SR 43.9% DR 22.5% Shaving 33.8%	To reduce pain and infertility	Hysterectomy + colectomy SR 3.6%, DR 5%, Shaving 29% Bladder resection SR 10.1%, DR 3.7%, Shaving 5.5%	. One year after the procedure 37.5% of infertile women became pregnant, and 33.3% of pregnancies were spontaneous. Three years after the procedure, the PR reached 66.7% and 50% of pregnancies were spontaneous.	Not reported	Not reported	Small sample size
Alborzi, 2022	SR N= 326 DR N= 248 Shaving N= 263	Left endometrioma 58.3%, right endometrioma 61.2%	Not reported	Not reported	failed IVF before surgery SR 51.1% DR 17.0% Shaving 29.6%	To reduce pain and/or infertility	right salpingectomy SR 47.7%, DR 50.6%, Shaving 41.3% left salpingectomy SR 53.5%, DR 56.5%, Shaving 51.7% right ureterolysis SR 14.1%, DR 9.8%, Shaving 11.3% left ureterolysis SR 15.6%, DR 9.8%, Shaving 10% ureteral reanastomosis SR 2%, DR 0.7%, Shaving 0% right oophorectomy SR 3.9%, DR 16.9%, Shaving 14.8% left oophorectomy SR 2.7%, DR 18.8%, Shaving 17.8%	spontaneous in shaving 27.6% Not reported in other group.	failed IVF before surgery SR 51.1% DR 17.0% Shaving 29.6%	abortion: Shaving 1.9% DR 4.4% SR 2.6%	Lack of datas on modality of conception after surgery.
Continued											

Reference	Surgical techniques	endometrioma	Preoperative characteristics of the digestive infiltration	Previous ovarian endometriosis surgery	Preoperative Infertile patients	Objectives of surgery (sub occlusive symptoms, worst cases of DIE or worst reproductive prognosis at baseline)	Additional surgery	Modality of conception (spontaneous vs. ART)	IVF before surgery	outcome pregnancy (spontaneous abortion, normal deliv. or c-sections)	Bias of the study
Bourdel, 2018	SR N= 23 Shaving N= 172	SR 90.9% Shaving 52.3%	Not reported	Not reported	SR 0% Shaving 6.9%	Pain SR 78.2%, Shaving 51.2%, infertility SR 0%, Shaving 7.5% infertility and pain SR 21.7%, Shaving 41.5%	Adhesiolysis SR 78.2%, Shaving 75% ureterolysis SR 69.6%, Shaving 68% colpctomy SR 30.4%, Shaving 75% Bladder resection SR 4.4%, Shaving 11.6% cystectomy SR 65.2%, Shaving 57.8% uterine nodule SR 0%, Shaving 2.4% oophorectomy SR 21.7%, Shaving 4%	SR Spontaneous pregnancies: 26%, IVF: 13% Shaving spontaneous pregnancies 36.2% IVF: 26.7%	Not reported	SR: 44.4% vaginal delivery, 44.4% CS, 11.1% miscarriage Shaving: 51% vaginal delivery, 25% CS, 13.8% miscarriages, 2.2% ectopic pregnancies, 2.2% therapeutic abortion, 1 abortion	Confusion: bias additional surgeries
Meuleman, 2014	SR N= 76 No SR N= 127	Not reported	Transmural bowel invasion SR 90% no SR 40%	Not reported,	Not reported	Infertility SR 5%, not SR 18% infertility + pain SR 90%, nit SR 74%	Bladder resection SR 20%, no SR 8% Ureter SR 78%, no SR 66% Salpingectomy SR 29%, no SR 9% Cystectomy SR 11%, no SR 23% Ovarectomy SR 8%, no SR 2%	SR spontaneous 23%, IVF 39% No SR spontaneous, 18.7% IVF	Not reported	Not reported	Monocentric study, response rate lower in no SR group
Stepniewska, 2009	SR N= 60 No SR N= 40	Not reported	Stenosis bowel resection SR 49%, no SR 23%,	Not reported	All	Sub occlusive symptoms all + infertility since > 1 year	caecum resection SR 6.6%, no SR 0% ileal resection SR 8.3%, no SR 0% vaginal resection SR 8.3%, no SR 0% bladder resection ST 8.3%, no SR 0% kystectomy SR 55%, no SR 60% , appendicectomy SR 1.6%, no SR 0% Salpingectomy SR 3.3%, no SR 5%	SR spontaneous 20%, IVF 8.3% No SR spontaneous 2.5%, IVF 2.5%	Not reported	Not reported	
Tuominen, 2021	SR N= 132 No SR N= 192	39.6% all	Not reported	Not reported	50.5% all	Pain 62.5% Infertility 1.1% Pain + infertility 33.3% Other 3.1%	Additional surgery on ovaries SR 68%; no SR 48%	Cumulative pregnancy rate 76.2% SR 76% no SR 74.5% Spontaneous 44.2% SR 32.1% no SR 48.8%	Not reported	LBR SR 62%, no SR 60% Vaginal delivery SR 55.1%, no SR 53.7% CS SR 44.9%, no SR 46.3%	Retrospective study, memory bias, selection bias and missing data

Continued

Reference	Surgical techniques	endometrioma	Preoperative characteristics of the digestive infiltration	Previous ovarian endometriosis surgery	Preoperative Infertile patients	Objectives of surgery (sub occlusive symptoms, worst cases of DIE or worst reproductive prognosis at baseline)	Additional surgery	Modality of conception (spontaneous vs. ART)	IVF before surgery	outcome pregnancy (spontaneous abortion, normal deliv. or c-sections)	Bias of the study
Vercellini, 2006	Rectal Surgery N = 44 (Shaving N = 38 DR N = 6) No surgery N = 61	0%	Not reported	0%	All with rectal endometriosis as unique factor of infertility	100% infertility	In rectal surgery group ureterolysis 13.6% segmental bladder resection 2.2%	Pregnancy rate 34% in rectal surgery group, 36% no surgery group IVF 29.5% in rectal surgery group 31% in no surgery group	Not reported	Not reported	Retrospective study, selection bias and missing data
Mohr 2005	SR N = 48 DR N = 39 Shaving N = 100	Not reported	100% infiltrative bowel disease	Not reported	32% all	Pain 99% Infertility 32% Bowel symptoms 74%	ALL: ureterolysis 45%, Adhesiolysis 13%, myomectomy 12%, colpectomy 11%, ureter 14%, bladder 9%, diaphragm 3%, cystectomy 4%, neurectomy 6%, ovariectomy 8%, hysterectomy 17%	Not reported	Not reported	At term delivery 78.5% (among all pregnancies) 17.8% miscarriages, 3.6% termination.	retrospective monocentric study
Breteau 2019	Surgery N = 104 SR N = 25 DR N = 4 Shaving N = 22	Not reported	Not reported	Not reported	All : 2 previous IVF or ICSI failures	100% infertility	urinary tract all 10.5% Right ovarian endometrioma : Cyst drained and washed all 7.7% ; plasma energy ablation all 25.9% Left ovarian endometriosis : Cyst drained and washed all 5.7% plasma energy ablation all 26.9% Cystectomy 2.9% Ovariectomy 1%	Pregnancy rate 43.8% 21.8% spontaneous, 10/78.2% IVF	All: 2 previous IVF or ICSI failures	53% delivery at term, 18.7% premature birth, 18.7% early miscarriage, 6.3% ectopic pregnancy, 1% molar pregnancy.	

Table 3. Study characteristics with surgical information. DR: disk excision, SR: segmental resection, CS: cesarean section CPR: cumulative pregnancy rate, LBR: life birth rate.

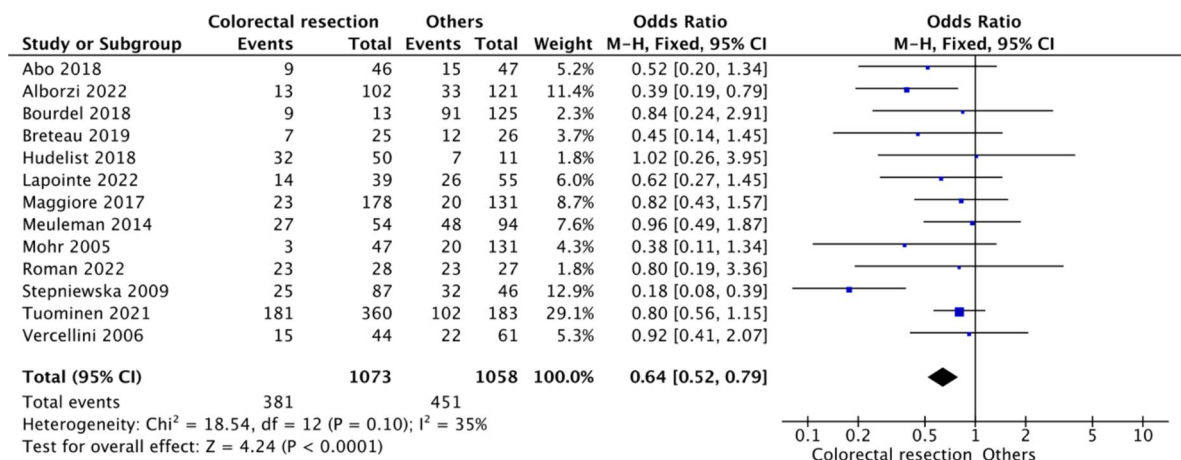


Fig. 2. Forest plot of the pregnancy rate comparing colorectal resection with other techniques.

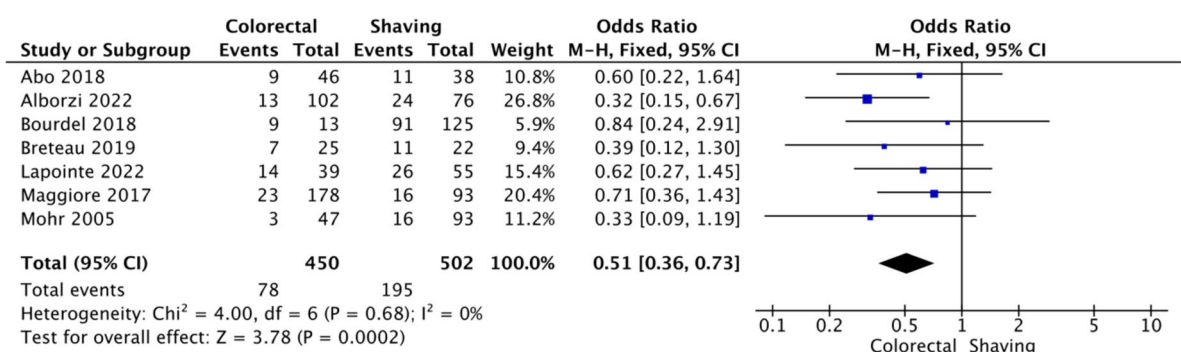


Fig. 3. Forest plot of the pregnancy rate comparing colorectal resection with shaving.

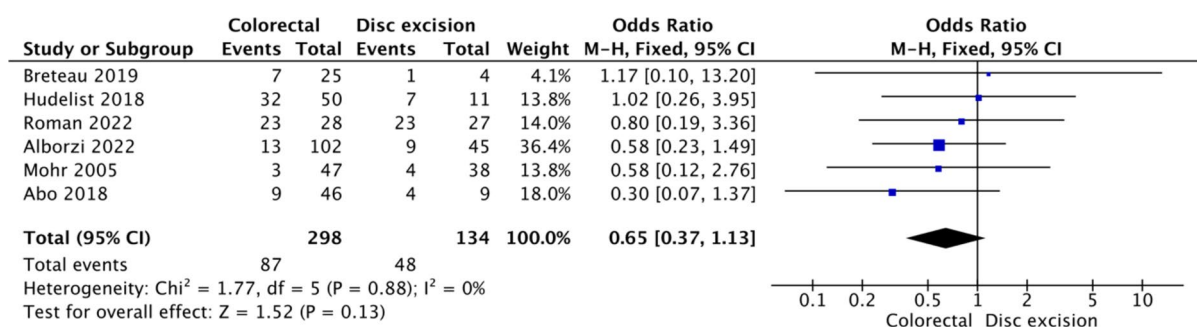


Fig. 4. Forest plot of the pregnancy rate comparing colorectal resection with disc excision.

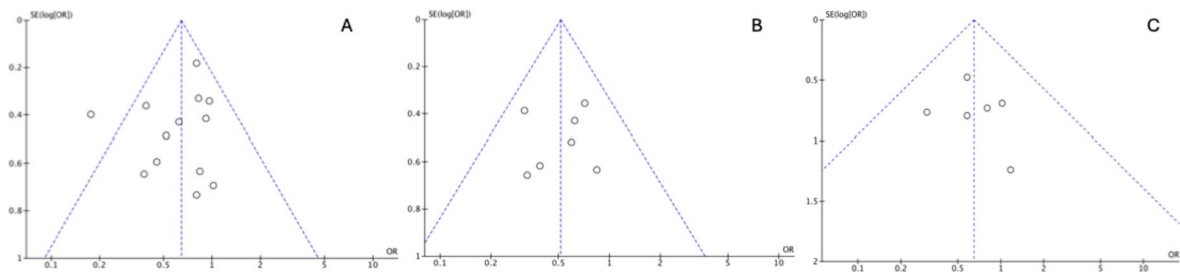


Fig. 5. Funnel plots for (A) colorectal resection compared with all options, (B) colorectal resection compared with shaving, and (C) colorectal resection compared with disc excision.

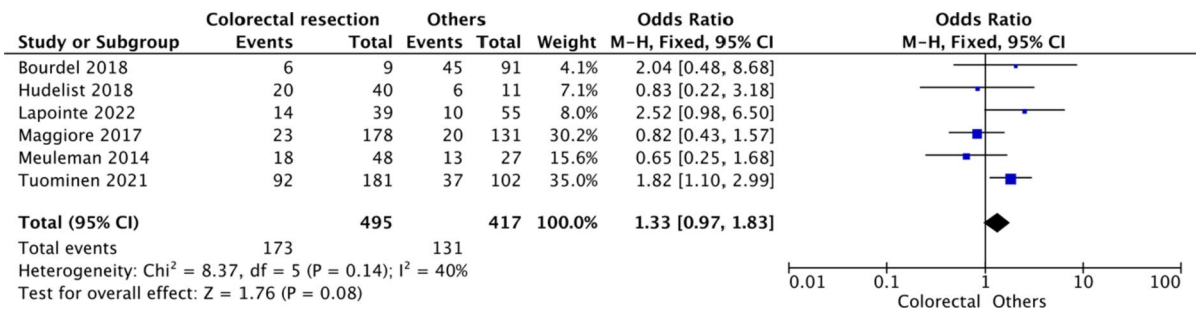


Fig. 6. Forest plot of the occurrence of spontaneous pregnancy rate comparing colorectal resection to other techniques.

Articles	Bias due to confounding	Bias in selection of participants into the study	Bias in classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of the reported results
Abo 2018							
Alborzi 2022							
Bourdel 2018							
Breteau 2019							
Hudelist 2018							
Lapointe 2022							
Maggiore 2017							
Meuleman 2014							
Mohr 2005							
Roman 2005							
Stepniewska 2009							
Tuominen 2021							
Vercellini 2006							

Table 4. Risk of bias. Red: high risk, yellow: moderate risk, green: low risk of bias.

Data availability

The dataset used and analyzed during the current study is available from the corresponding author on reasonable request.

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Declarations

Competing interests

The authors declare no competing interests.

Additional information

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