

# A Practical Approach to Fertility Considerations in Endometriosis Surgery



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## KEYWORDS

- Endometriosis • Minimally invasive surgery • Fertility • Deep endometriosis
- Endometriomas • In vitro fertilization

## KEY POINTS

- Endometriosis affects 5% to 10% of reproductive-age women, and the prevalence among women with infertility has been reported as high as 50%.
- Endometriosis surgery can improve the chance of spontaneous conception; however, surgery for endometriosis-related infertility requires thoughtful evaluation, planning, and patient counseling.
- In the absence of other surgical indications (ie, pain), there is a lack of good quality evidence to support first-line surgery to improve fertility treatment outcomes.
- A personalized approach to each patient should consider symptoms including pelvic pain, past fertility and surgical interventions, extent of disease, and the need to treat coexisting conditions.

## INTRODUCTION

Endometriosis is a disease characterized by the presence of endometrium-like epithelium and/or stroma outside the endometrium and myometrium, usually with an associated inflammatory process.<sup>1</sup> It is a common condition among reproductive-age individuals assigned female sex at birth and is often associated with infertility. Approximately 1 in 10 girls and women, and unmeasured numbers of transgender, nonbinary, and gender diverse individuals, will have endometriosis. Among women with pelvic pain, the prevalence of endometriosis increases to 50% to 70%.<sup>2</sup> The prevalence

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among patients with infertility has been reported as high as 50%, and infertile patients are 6 to 8 times more likely to have endometriosis than fertile women.<sup>2,3</sup>

The mechanism by which endometriosis impacts fertility is likely multi-factorial and may involve the entire reproductive tract through structural and functional impairment. Severe adhesive disease associated with advanced endometriosis is an obvious impairment to fertility, affecting ovum release and capture; however, the full extent of the association of endometriosis with infertility remains unresolved. Endometriosis has been implicated at many levels beyond distorted pelvic anatomy, including cycle irregularity, impairment of follicular growth, lower oocyte and embryo quality, luteal phase dysfunction, altered peritoneal function, impaired fertilization, and reduced implantation rates, among others.<sup>4,5</sup> Although the relationship between endometriosis and infertility is indisputable, accurately predicting fertility among those with endometriosis is challenging.

Endometriosis has several different phenotypes (peritoneal, ovarian endometriomas, and deep disease) and may also be associated with other pathologies such as adenomyosis and uterine fibroids. The lack of accounting for coexisting conditions can lead to diagnostic biases when evaluating fertility outcomes among patients with endometriosis. As a result of these challenges, predicting which patient will benefit from surgery, from both a quality of life (QOL) and fertility perspective, is difficult. In this article, we will discuss important considerations with regards to fertility and endometriosis surgery, including an approach to selecting the appropriate candidate for surgery, surgical techniques, and special considerations.

### ***Endometriosis Staging***

The American Society for Reproductive Medicine (ASRM) scoring system is the most widely used classification system. It categorizes endometriosis into 4 stages of minimal (stage I), mild (stage II), moderate (stage III), and severe (stage IV)<sup>6</sup> (Fig. 1). The ASRM classification system, however, does not correlate with symptoms or prognosis of endometriosis, and heterogeneity of symptoms is high among patients with endometriosis.<sup>2</sup> The ASRM scoring also does not accurately reflect deep endometriosis (DE) involvement which limits its use in those cases.

While many other classification systems have been proposed, a recent systematic review on endometriosis staging systems concluded that there is a lack of agreement on classification globally and “no or very little correlation with patient outcomes.”<sup>7</sup> A new surgical complexity classification system proposed by the AAGL helps to provide a practical approach to predicting/describing surgical complexity better than the ASRM staging previously proposed.<sup>8</sup>

The classification systems discussed above, however, have limited utility in predicting pregnancy outcomes after gynecologic surgery for endometriosis. The endometriosis fertility index (EFI) is a clinical tool developed to predict postoperative spontaneous pregnancy rates among patients after surgical diagnosis and treatment of endometriosis<sup>9</sup> (Fig. 2). The tool was developed to provide reassurance for patients with good prognosis for spontaneous conception, and triaging those with poor prognosis to assisted reproductive technology (ART) and avoid wasted time. This tool has been shown to have good inter-expert clinical agreement<sup>10</sup> and has demonstrated good predictive performance in a recent systematic review and meta-analysis.<sup>11</sup>

#### **Clinical tip**

The use of endometriosis staging systems helps document surgical findings, which may improve communication among care providers. The EFI may help guide postoperative fertility management decisions.

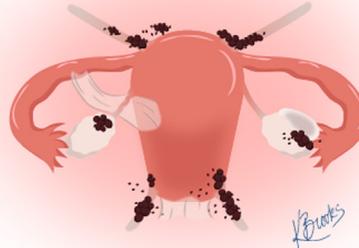
Stage 1 - Minimal (1-5 points)

Stage 2 - Mild (6-15 points)

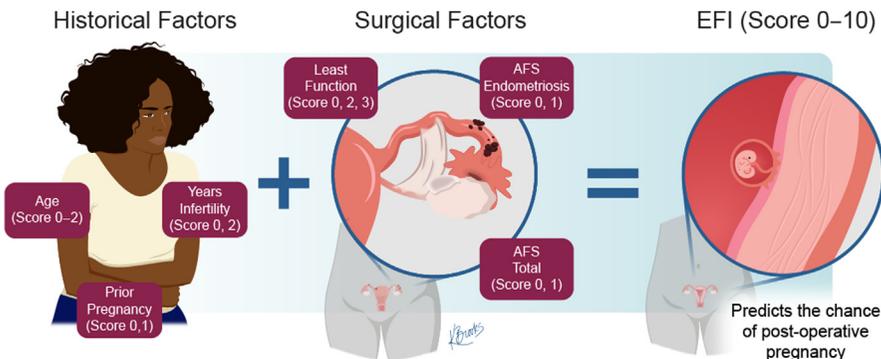


Stage 3 - Moderate (16-40 points)

Stage 4 - Severe (>40 points)



**Fig. 1.** American Society for Reproductive Medicine (ASRM) endometriosis scoring system. (Adapted from Revised American Society for Reproductive Medicine classification of endometriosis: 1996. Fertil Steril. 1997;67(5):817-821. [https://doi.org/10.1016/s0015-0282\(97\)81391-x](https://doi.org/10.1016/s0015-0282(97)81391-x); with permission. Reprinted by permission from the American Society for Reproductive Medicine.)



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**Fig. 2.** Endometriosis fertility index (EFI). (Adapted from Revised American Society for Reproductive Medicine classification of endometriosis: 1996. Fertil Steril. 1997;67(5):817-821. [https://doi.org/10.1016/s0015-0282\(97\)81391-x](https://doi.org/10.1016/s0015-0282(97)81391-x); with permission. Reprinted by permission from the American Society for Reproductive Medicine.)

### ***Clinical Evaluation***

Endometriosis influences almost every aspect of a patients' fertility from ovulation, fertilization, embryo implantation, risk of miscarriage, and risk in pregnancy. What is less clear is what the role is for surgery with regards to improving fertility. Theoretically, surgical treatment of endometriosis might improve the environment for successful conception and ongoing pregnancy. However, potential benefits of surgery need to be balanced with the risk of surgical intervention, including delay in assisted fertility treatments. The approach to the individual patient whereby fertility is a priority in deciding whether surgery is recommended is unique and dependent on several factors.

#### ***Initial patient evaluation***

A complete evaluation of the full extent of endometriosis is required through history, physical examination, and imaging.<sup>12</sup> A thorough initial work-up is imperative and should include:

- Detailed history to determine the extent of symptoms, past treatments, and patient goals;
- Abdominal, speculum and bimanual examination to evaluate ovarian masses, pelvic organ mobility and the presence of DE;
- Imaging including transabdominal and transvaginal ultrasound (TVUS) (and/or MRI). The detection of endometriosis can be optimized through the use of a targeted protocol for sonographer-acquired images and maneuvers at the time of endovaginal sonographic imaging.<sup>13</sup> Systematic and targeted pelvic imaging should evaluate for signs of:
  - Ovarian endometriomas
  - Hydro/hematosalpinx
  - Mobility of pelvic organs (sliding sign), obliteration of the posterior cul-de-sac
  - DE deposits, with or without bowel involvement
  - Hydro-ureter, hydronephrosis
- Full evaluation of the risk of malignancy, with the risk of malignancy scoring when applicable

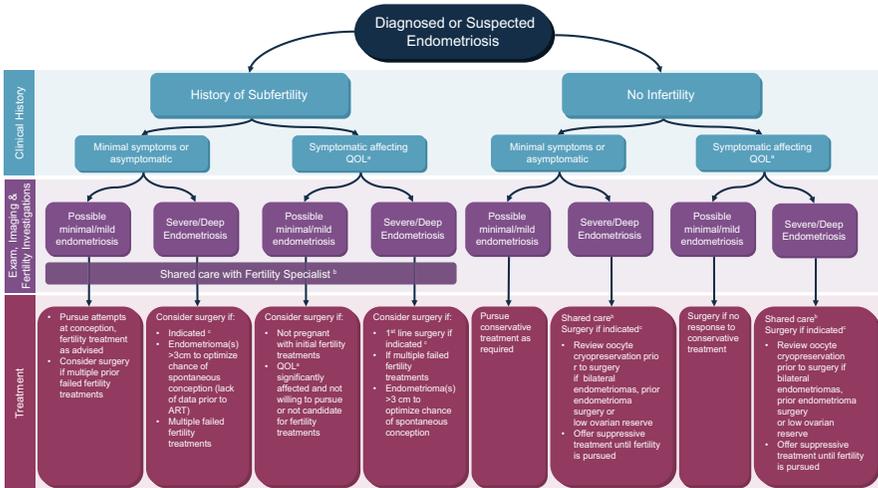
After a thorough clinical evaluation of the extent of endometriosis and its impact on QOL and an individual patients' current or future desire for pregnancy, a tailored approach should be taken regarding whether to proceed with surgery. In particular, adequate pelvic imaging to understand the full extent of endometriosis can help inform the indication for surgery. Importantly, many patients with advanced disease may have a "normal" routine TVUS and it is important to maintain a high level of clinical suspicion.

In general, surgical treatment is considered for women with endometriosis resistant to medical therapy, among other considerations. **Fig. 3** outlines an approach to selecting a surgical candidate based on impact on QOL, stage of endometriosis, and whether patients have a history of infertility.

#### ***Clinical history and examination***

A detailed clinical history is imperative to assist in the evaluation of the extent of endometriosis and its impact on patient QOL and goals. Particular attention should be paid to symptoms that could be attributed to endometriosis. Specifically, the following details should be sought on history<sup>12</sup>:

- Age;
- Body mass index (BMI);



**Fig. 3.** Approach to managing patients with diagnosed or suspected endometriosis who are contemplating fertility. <sup>a</sup>QOL, quality of life. <sup>b</sup>Shared care with a fertility specialist where available. <sup>c</sup>Indications: rule out malignancy, manage visceral obstruction and/or patient request.

- Number and outcome of prior pregnancies;
- Subfertility and its duration;
- Outcome of fertility consultation and investigations;
- Prior fertility treatment(s) and their outcome(s);
- Current fertility goals (ie, actively trying for pregnancy, long-term fertility preservation, undecided)
- Menstrual history;
- Prior gynecologic surgery (including surgery for endometriosis);
- Pain (pain with menses, intercourse, urination, bowel movements, chronic pelvic pain);
- Blood in the urine or stool;
- Results of prior pelvic imaging.

The pain should be further explored, with quantification on a scale of 0 to 10 or with the use of a visual analog scale (VAS).

A thorough examination, as described by Vilasagar and colleagues,<sup>12</sup> for those with suspected endometriosis and/or pelvic pain with infertility is crucial. Identifying obvious cul-de-sac nodularity, pelvic masses, and areas of pain will guide next steps and imaging.

### Key Examination Tips

- An abdominal and pelvic exam should assess for sites of pain and identify:
  - Masses
  - Allodynia or hyperalgesia
  - Muscle tone and tenderness (pelvic floor and abdominal wall)
  - Previous scars or injury
  - Nodularity along the vaginal fornices or cul-de-sac

- Uterine mobility and axis
- Neurological patterns of pain or sensory deficits
- Pelvi-rectal examination may help identify recto-vaginal fullness or nodularity
- Speculum exam may help identify vaginal lesions of endometriosis

### **Imaging**

Transvaginal ultrasound is the first-line imaging for the diagnosis of endometriosis. While routine TVUS can readily pick up more obvious signs of endometriosis (ie, ovarian endometrioma), routine TVUS will miss the diagnosis of endometriosis in 3 out of 4 patients who have this prevalent condition.<sup>14</sup> Therefore, routine pelvic ultrasound is a valuable first-line imaging; however, patients with a higher degree of suspicion of endometriosis (based on the history of physical examination described above), or all patients with the history of infertility given the prevalence of endometriosis among this population, should undergo more detailed systematic imaging evaluation for endometriosis.

A simple systematic approach to evaluating sonographic features of endometriosis was developed and validated to improve the diagnostic accuracy of TVUS and standardize nomenclature.<sup>15</sup> This systematic approach to TVUS evaluates “soft markers” (ie, site-specific tenderness and ovarian mobility), “sliding sign” (suggestion of posterior cul-de-sac adhesion involvement) and assesses for DE nodules.<sup>15</sup> Additionally, pelvic imaging should comment on signs of hydro-hematosalpinx, hydroureter/hydro-nephrosis. MRI may assist in further preoperative mapping of endometriosis, especially in cases of multi-organ involvement especially beyond the pelvis and in cases whereby there is a lack of access to expert-guided ultrasound.<sup>16</sup> A standardized approach for MRI and ultrasound are essential for proper communication with surgeons and care teams.<sup>16</sup>

### **Preparing for Surgery**

A multidisciplinary approach to the patient undergoing surgery whereby fertility is a priority is imperative. Patients should undergo preoperative referral to a fertility specialist for fertility investigations and counseling of their options to make a fully informed decision regarding their care.

Preoperative focused fertility investigations include:

- Ultrasound to evaluate ovarian accessibility for oocyte retrieval
- Partner semen analysis (when indicated)
- Ovarian reserve testing including anti-Mullerian hormone (AMH) level and antral follicle count
- Tubal patency evaluated through hysterosalpingogram (HSG) or hysterosalpingo-contrast sonography (HyCoSy)

### **Clinical tip**

Tubal patency evaluation is important preoperatively for surgical planning. In cases of hydrosalpinx that communicate with the uterine cavity (patent cornua), salpingectomy should be undertaken before ART treatment. Communicating hydrosalpinges are associated with lower implantation rates at the time of embryo transfer,<sup>17</sup> and fimbrioplasty is of limited utility. In cases of bilateral salpingectomy, patients must be fully informed that this will preclude spontaneous conception, given that although the chance of spontaneous pregnancy is rare with bilateral hydrosalpinges/blocked tubes, patients not wishing to undergo or not candidates for ART may opt against surgery.

Among cases of suspected tubal blockage without hydrosalpinx, the decision for salpingectomy is individualized and factors that influence this decision include age, whether they are a candidate for ART, willingness to undergo ART, history of prior ectopic pregnancies, and the appearance and patency of the fallopian at the time of surgery.

### ***Preoperative fertility preservation***

In any case of suspected or diagnosed endometriosis, presurgical discussion of fertility preservation (either through oocyte or embryo cryopreservation) should be considered, secondary to the potential negative impact of the surgery on ovarian reserve and ovarian accessibility for a future oocyte retrieval procedure.

There is a paucity of evidence surrounding the role of fertility preservation for patients with endometriosis before surgery. As a result of lack of data on the survival rate of cryopreserved oocytes, reproductive potential, patient satisfaction, and cost-effectiveness, oocyte cryopreservation is not standard practice before surgery for advanced endometriosis. However, there may be a role for preoperative fertility preservation in specific circumstances, particularly when the risk of damage to ovarian reserve or premature ovarian insufficiency is high. Patients with (1) bilateral endometriomas, (2) prior excision of unilateral endometriomas who require surgery for contralateral recurrence<sup>18</sup>, and (3) low ovarian reserve may benefit from preoperative fertility preservation. However, fertility preservation among patients with low ovarian reserve or endometrioma(s) is not always feasible or possible.

### ***Clinical tip***

Consider referral to a fertility specialist for counseling about the option of fertility preservation before surgery for endometriosis for patients with bilateral ovarian endometriomas, prior excision of ovarian endometriomas, and/or low ovarian reserve.

### ***Preoperative counseling***

In addition to preoperative counseling regarding the option of fertility preservation, risks and benefits of laparoscopic treatment of endometriosis must be reviewed. Unfortunately, due to the significant heterogeneity in surgical approaches, disease variation, and patient comorbid factors, there is no simple overall risk “number” that can be quoted. Each case is unique and requires an individual discussion including the following risks:

- Risk of reduction in ovarian reserve (and lower postoperative oocyte yield for ART);
- Risk of oophorectomy or premature ovarian insufficiency;
- Risk of ovarian inaccessibility for future oocyte retrieval and;
- Risk of postoperative adhesions causing tubal dysfunction or blockage.

## ***Surgical Indications for Endometriosis-Related Subfertility***

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### ***Minimal and mild endometriosis***

Laparoscopic treatment of minimal or mild endometriosis is associated with a small but significant improvement in live birth rates.<sup>19,20</sup> Two randomized controlled trials (RCTs) have studied whether laparoscopic treatment of endometriosis, by ablation or excision, is associated with improved spontaneous pregnancy rates. The first study, which included 341 infertile women ages 20 to 39, found that women randomized to the treatment group were almost twice as likely to achieve pregnancy over a 36-month follow-up period (with an increased monthly pregnancy rate from 3% to 6%).<sup>19</sup> In contrast to this study, a second RCT of 101 patients did not show a difference in

pregnancy rates.<sup>20</sup> When the results of these 2 studies are combined, the number needed to treat (NNT) to achieve one additional pregnancy among women with mild or moderate endometriosis is 12.<sup>5</sup> However, the challenge in interpreting this data is that not all patients with infertility who undergo diagnostic laparoscopy for possible endometriosis will have minimal or mild endometriosis, and therefore if we consider a conservative common prevalence of 30% among women with unexplained infertility, the adjusted NNT would be 40.<sup>5</sup> As a result of these findings, international guidelines do not support the use of routine diagnostic laparoscopy for couples with unexplained infertility to rule out and potentially treatment minimal to mild endometriosis.

Among patients with known or suspected endometriosis, surgery may be reviewed as an option in the setting of failed treatment with superovulation with intrauterine insemination (SO-IUI) or ovulation induction, before IVF. Treatment with SO-IUI is not generally recommended for patients with more advanced endometriosis (given distorted pelvic anatomy and altered tubal function). However, there is a lack of evidence to suggest that failed SO-IUI treatment is an indication for surgical treatment of endometriosis, and given that IVF maximizes cycle fecundity among patients with endometriosis,<sup>5</sup> IVF is generally the next step among patients who fail SO-IUI treatment. The counseling around the potential risks and benefits of surgery for these patients is similar to those with infertility who have not attempted IVF.

### ***Clinical tip***

Indications for surgery among patients with unexplained infertility and suspected minimal to mild endometriosis (ASRM Stage 1–2) include:

- Endometriosis-related symptoms with a goal to improve QOL.
- When fertility treatment options are not accessible (ie, due to cost or geography) or the patient is not a candidate for or declines fertility interventions.

### ***Ovarian Endometriomas***

Approximately 17% to 44% of patients with endometriosis have ovarian endometriomas.<sup>21</sup> More easily appreciated on diagnostic evaluation through TVUS, ovarian endometriomas are a marker for more extensive pelvic and intestinal disease, as only approximately 1% of patients with endometriomas have ovarian disease exclusively.<sup>22</sup> Additionally, among patients with ovarian endometriomas, deep lesions are more severe with an increased rate of vaginal, intestinal and ureteral involvement.<sup>23</sup>

Laparoscopic cystectomy for ovarian endometriomas greater than 3 cm is associated with improved fertility relative to cyst drainage and coagulation.<sup>24</sup> For patients who are subsequently attempting to conceive after surgical management of endometrioma, excision is associated with an increased spontaneous pregnancy rate among patients who had documented prior subfertility (OR 5.21, CI 2.04–13.29).<sup>25</sup> In addition to the size of the endometriomas, indications for surgery include inability to access follicles as a result of the endometrioma(s) among patients who will undergo ART, rapid growth and suspicious features noted on ultrasound.<sup>18,26</sup>

Current evidence does not suggest that cystectomy improves fertility outcomes among patients before IVF.<sup>27</sup> Outcomes after IVF including implantation rates, clinical pregnancy rates and live birth rates are similar when comparing patients who undergo cystectomy for endometrioma versus controls.<sup>28</sup> Ovarian endometrioma cystectomy is not routinely recommended before IVF and is most often considered before IVF for patients whereby access to follicles is impaired, who have significant pain and/or atypical imaging findings requiring pathologic diagnosis.<sup>5</sup>

Patients with endometriomas (without surgery) have lower ovarian reserve and a steeper decline in ovarian reserve.<sup>29</sup> Additionally, patients who undergo ovarian cystectomy for endometriomas have a reduction in the ovarian reserve as measured by AMH level.<sup>30</sup> These AMH levels may recover over time; however, the rate and degree of recovery of AMH varies. Unfavorable factors that are associated with impaired recovery include baseline infertility and increased cyst burden.<sup>30</sup> Patients with larger endometriomas or bilateral endometriomas are at increased risk of further diminished ovarian reserve after ovarian cystectomy. The risk of postsurgical premature ovarian insufficiency after excision of bilateral endometriomas is approximately 2% to 3%.<sup>31</sup>

Recurrence of endometriomas is a significant concern, and the recurrence of endometriomas may be as high as 50% without suppressive therapy.<sup>32,33</sup> Younger age at surgery, stage of endometriosis, size of the endometrioma and previous medical or surgical treatment are suggested risk factors for endometrioma recurrence.<sup>32</sup> Although a barrier to conception, the use of medical therapy is effective at reducing the risk of recurrence.<sup>33,34</sup> Therefore, the pursuit of ART is typically recommended among patients trying to conceive if conception has not occurred in a relatively short time period after surgery.

#### **Clinical tip: for ovarian endometriomas**

- Consider surgery for the patient with infertility if endometrioma size greater than 3 cm and there is a desire for *spontaneous conception*.
- Consider surgery if there are rapid growth or suspicious features of the endometrioma on ultrasound, the inability to access ovarian follicles for oocyte retrieval, and/or symptoms significantly impacting the QOL.
- Surgery should be cautiously used in cases of ovarian endometriomas due to the risk of reduction in ovarian reserve or premature ovarian insufficiency.
- Repeat or bilateral ovarian surgery further increases the risk of damage to ovarian reserve.
- Postoperative recurrence of endometriomas is high without medical suppression.

#### **Deep Endometriosis**

Deep endometriosis (DE) is defined as endometrium-like tissue lesions extending on or under the peritoneal surface. They are usually nodular, able to invade adjacent structures, and associated with fibrosis and disruption of normal anatomy. The predominant symptom of DE is pain. The type of painful symptoms and the intensity of pain are related to the anatomic location and the depth of penetration of the DE lesions, respectively.<sup>35</sup>

Studies evaluating fertility outcomes after surgery for DE are heterogeneous and inherently biased. Among patients who pursue surgery for DE, the spontaneous pregnancy rate after surgical resection of DE is 21% to 49%.<sup>36</sup> There are no RCTs evaluating whether first-line IVF versus first-line surgery for infertile patients with DE yields better live birth rates. In a recent meta-analysis of 12 cohort studies, none of which were RCTs, studies were consistent in demonstrating a benefit for surgery before IVF.<sup>37</sup> These results need to be evaluated with extreme caution, given the high heterogeneity in the reported data and the significant risk of selection and allocation bias. As an example, most fertility specialists would not recommend surgery for those who have a low ovarian reserve before IVF. These patients will have inherently lower success rates with IVF, thus significantly biasing nonrandomized study results.

Randomized control trials are necessary to determine whether surgery before IVF among patients with DE leads to higher live birth rates. There is insufficient evidence

to routinely recommend surgery before IVF for patients with DE. Currently, the main indications for surgical management of DE-related infertility are to manage pain or visceral (bowel, ureteric) obstruction. For patients with the recurrence of DE after a first surgical excision in experienced hands, among whom fertility is the main goal of treatment, repeated excision is not recommended.<sup>38,39</sup> Among these patients, ART leads to better results compared with a repeat operation.

Bowel endometriosis presents a particular challenge for the gynecologic surgeon and fertility specialist. A skilled, experienced multidisciplinary team comfortable with bowel endometriosis is a necessity for optimal outcomes and low complication rates. However, there is no clear consensus on whether surgery before ART or direct to ART is preferred for patients with DE and bowel involvement.<sup>40</sup> Additionally, although surgical management of bowel endometriosis is associated with significant improvement in overall well-being, it presents significant intra and postoperative risk including, but not limited to, rectovaginal fistula formation, hemorrhage, infections, conversion to laparotomy, bladder and bowel dysfunction.<sup>40</sup> Complications after bowel surgery for endometriosis, even in expert centers, are reported between 10% and 25%, which should be discussed in advance with the patient and their family.<sup>41</sup> It is generally accepted that for asymptomatic patients with bowel endometriosis whereby fertility is the primary goal, ART is the first-line option.<sup>40</sup>

The role of surgery among patients with multiple prior failed ART cycles/embryo transfers is not clear. One study evaluated surgery after repeated IVF failures and found that after surgical treatment, 42% of patients delivered (9% spontaneous conceptions and the remainder through additional IVF).<sup>42</sup> The study setting was highly unique environment of multiple funded IVF cycles, whereby the average number of cycles was 6 and for many of these patients this was not their first surgery for endometriosis; therefore, this data is difficult to extrapolate to other populations. However, there is likely a role of surgery among patients with repeated IVF failures before further fertility treatment.

### ***Clinical tip: surgery for deep endometriosis***

- The management of bowel endometriosis requires careful consideration of symptoms, patient goals, and an experienced team with surgical and fertility experience.
- Approximately one-third of patients who have surgery for DE, in centers with expertise, will achieve spontaneous conception.
- ART is generally chosen as first line over surgery for patients wishing to conceive, whereby fertility is the primary concern.
- There is likely a role for surgery among patients with repeated failed ART cycles.

### ***Mitigation of Risk in Pregnancy***

Patients with endometriosis are possibly at increased risk of pregnancy complications, including placenta previa, preterm birth, low birth weight, and cesarean delivery, among other pregnancy complications, compared with patients without endometriosis.<sup>43</sup> It is unknown whether surgical treatment of endometriosis before pregnancy will reduce these possible associated risks in future pregnancy. Patients with the history of recurrent significant pregnancy complications (ie, recurrent first or second trimester losses) may consider surgical treatment of endometriosis to mitigate risk in pregnancy when other options have failed. However, there is a significant paucity of evidence to support this indication for treatment, and thorough preoperative counseling of risks associated with endometriosis surgery must be reviewed.

**Clinical tip**

There is no evidence that surgical treatment of endometriosis before pregnancy will improve pregnancy outcomes and as a result is not an indication on its own.

**Additional surgical considerations**

Additional considerations exist that may inform the decision to pursue surgery. Individual religious and/or sociocultural backgrounds and financial situations may strongly influence fertility options. An open discussion between patient and provider is essential in the determination of what options are acceptable. Individual religions have varied views on the acceptability of different forms of ART.<sup>44</sup> Finally, government or insurance funding for ART is not universal and there may be significant financial barriers to the pursuit of fertility treatments. Therefore, surgery may be the only acceptable option.<sup>45</sup>

**Approach to Surgery: Intra-Operative Considerations**

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**Step 1: verify the goal of surgery**

The approach to surgical management of endometriosis begins with a thoughtful pre-operative evaluation to determine the extent of expected disease, the impact on the patient (symptoms), and the goals of intervention. The personalized approach for endometriosis care is a patient-centered perspective, in contrast to the disease-centric viewpoint which would focus solely on disease eradication (Fig. 4). Ultimately the “goal” of surgery should consider each aspect and reduce the harm while maximizing the benefit to the patient.

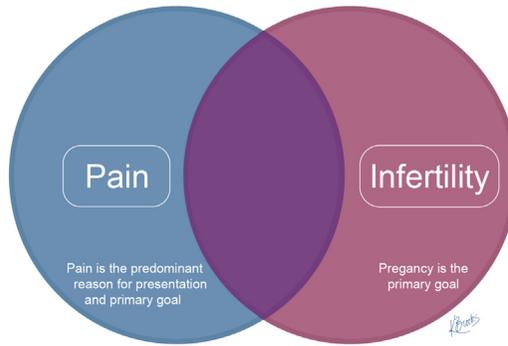
**Step 2: surgical approaches**

When fertility preservation or optimization is considered, the surgical approach must be balanced with improving outcomes while managing the risk of harm. Essentially, any surgery for endometriosis is a complex balancing act between maximum disease management and sparing normal function and organs.

**Excision versus ablation.** Based on the data extracted from a recent systematic review and meta-analysis, no significant difference between laparoscopic excision and ablation was noted in regard to improving pain from minimal and mild endometriosis.<sup>46</sup> This discussion is limited to superficial disease as the management of DE cannot be managed by ablation alone. Excision of deep disease is best managed by those with expertise and appropriate skills to manage the retroperitoneum and adjacent organ involvement (bladder, bowel, ureter).

**Cystectomy versus ablation or electrocoagulation for endometriomas.** Damage to the ovary can occur at several steps during the surgical approach to an endometrioma, including removal of normal ovarian cortex containing follicles during ovarian dissection, and damage incurred while obtaining hemostasis. Several surgical techniques are proposed for the surgical management of endometriomas.

In general, ovarian cystectomy or excision of the endometrioma is preferred over ablation or electrocoagulation as it is associated with a reduction in the recurrence of the endometrioma, long-term pain relief, and increase in spontaneous pregnancy rates.<sup>25</sup> However, the risk of harming ovarian reserve, as outlined above, should be considered. There has been a call to reconsider ablation of ovarian endometrioma in selected cases with carbon dioxide laser and plasma energy in cases of infertility.<sup>47</sup> This “conservative” approach addresses the goals of the patient, and if fertility is the priority, then the least harm with the best outcome should be the goal instead of complete and radical excision. Furthermore, among women who will subsequently



**Fig. 4.** Goal setting—pain, infertility, or both.

undergo fertility treatment after surgery for endometrioma, there is insufficient evidence to favor excisional surgery over ablative surgery.<sup>48</sup>

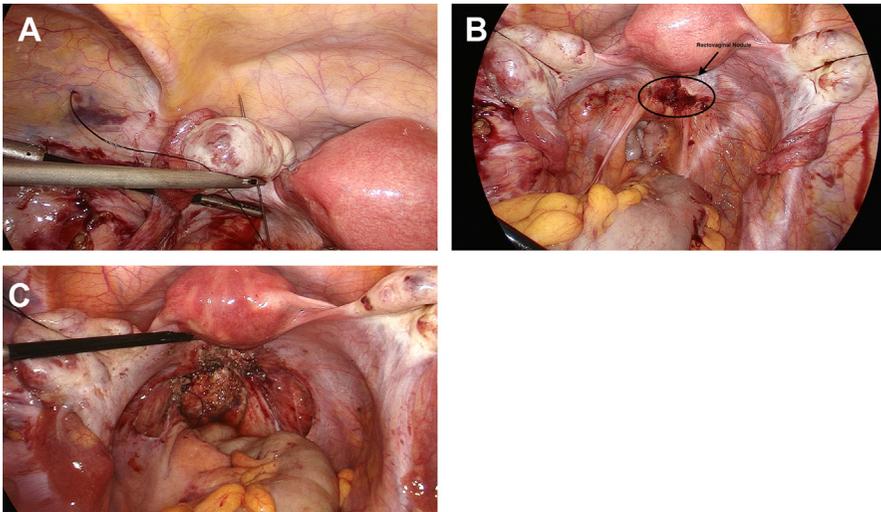
### **Step 3: adhesion prevention**

**Adhesion barriers.** At the completion of the procedure, anti-adhesions measures have been used in an attempt to reduce postoperative adhesion formation and when applicable place ovaries within the posterior cul-de-sac or close to the vaginal apex for ease of future transvaginal oocyte retrieval. However, there is no overwhelming data in the literature which supports any specific anti-adhesion material or intervention for pelvic surgery.<sup>49</sup> This is further complicated by the significant heterogeneity of the endometriosis presentation and surgical interventions. Novel interventions are ongoing and show promise, including a recent randomized control trial by Krämer and colleagues<sup>50</sup> demonstrating benefit at 2 months post endometriosis surgery of an anti-adhesion agent at second-look laparoscopy. Further research in this space is required before generalizability for all endometriosis surgical cases.

**Temporary ovarian suspension.** Ovarian adhesions to the sidewall or uterus are likely some of the most problematic adhesions among patients who are under surgery for endometriosis. Temporary ovarian suspension has been proposed as one method to prevent this scenario. The thought is that if the ovaries are lifted from the pelvic sidewall, bowel, or cul-de-sac, they may not adhere in the long term (Fig. 5A–C). This type of suspension has been described with suture tied outside the abdominal wall or with quickly dissolving intra-abdominal suture material. A systematic review on the topic by Giampaolino and colleagues demonstrated the potential positive outcomes of this intervention; however, further RCTs with larger sample sizes are required.<sup>51</sup> The concept and data are promising; however, still require larger studies with improved ultrasound experience to evaluate the impact on ovarian accessibility for oocyte retrieval.

### **Step 4: know when to stop**

The complete eradication of endometriosis has long been advocated among surgeons who focus on this disease process. Complete “excision” has been touted as the gold standard of care. For those with infertility or wishing to preserve fertility, this approach may lead to more harm than benefit. If a patient has no symptoms other than infertility, is it necessary to always perform aggressive visceral resection (especially in nonobstructive disease processes)? This fundamental question leads to the importance of the surgical team taking the step of intraoperative decision making to assist with patient care. In the ideal world, thorough evaluation with excellence in imaging would provide a complete preoperative plan for every patient. However, the reality is that



**Fig. 5.** (A) Temporary ovarian suspension (to external abdominal wall); (B) Facilitates exposure for managing deep endometriosis of the posterior compartment; (C) Temporary suspension sutures may be removed 24 to 72 hours later to theoretically prevent adhesions.

imaging is highly variable globally and the skill set of surgeons is also not uniformly established. As a result, it is important to identify one's limits as a surgeon and to establish a risk mitigation approach among patients whereby fertility is a priority. This honest and frank discussion with the patient and team is essential to reduce complications and optimize outcomes after surgery.

## SUMMARY

Determining the role of surgery for endometriosis among those with related infertility or those with future fertility goals can be challenging. Endometriosis has a wide variety of clinical and pathologic presentations which makes it almost impossible to have a single approach for all patients and this is further reflected by the lack of high-quality evidence to guide decision making. In general, for patients with endometriosis-related infertility who wish to achieve pregnancy, ART is preferred over surgery. However, a personalized approach to care is necessary, and a thorough history, physical examination, and imaging will help inform the decision for surgery and counseling regarding the risks and benefits of surgery. The patient with significant pain, risk of malignancy, or disease resulting in organ obstruction or dysfunction is best managed with surgical care by an experienced team including consultation with a fertility specialist. Surgery should be considered cautiously among patients whereby fertility is a priority, given the risk of postoperative adhesions and damage to ovarian reserve. The classic surgical perspective that dictates mandatory radical excision of "all endometriosis" may be better replaced by goal-directed surgical treatment of endometriosis in this population. If the goal is pregnancy in the future, then surgical care should enhance that outcome when possible.

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