9 Surgical Treatment of Deep Endometriosis

Rodrigo Fernandes, Karolina Afors, and Arnaud Wattiez

Introduction

- Endometriosis is a complex gynecological disease, which presents a challenge for researchers and surgeons alike. Ectopic deposits of endometrial tissue typically found in the pelvis contribute to disease progression. Associated symptoms of pain and infertility are often attributed to adhesion formation and anatomical distortion frequently responsible for the clinical consequences of the disease [1]. Endometrial tissue within the uterine cavity is responsible for preparing the embryo implantation and nourishing the developing fetus. In the absence of a pregnancy, the corpus luteum degenerates, and hormone levels drop, the effect of which results in shedding of the endometrial lining. This continuous cycle exposes women to constant fluctuations in hormones levels, which in turn regulates the endometrium.
- Endometriosis most commonly affects the ovaries, posterior cul-de-sac, and uterosacral ligaments [2]. Less frequently affected sites including the diaphragm, lungs, and even endometriotic implants involving the brain have been described [3].

Theories

- Although endometriosis is commonly encountered, its pathogenesis remains poorly understood. Since Sampson's report was first published, numerous theories have been proposed; however, none can fully explain the pathogenesis of this disease. Among these theories, three main concepts are most widely accepted.
- In 1927 Sampson's hypothesis attributed pathogenesis of endometriosis to retrograde menstruation [4]. His theory postulated that endometriosis occurs due to retrograde flow of endometrial debris into the peritoneal cavity during menstruation. He established his theory by observing 20 women presenting with ovarian cysts and implants containing endometrial tissue within the peritoneal cavity. Another theory proposed the existence of Müllerianosis, defined as residual cell of embryonic origin, composed of Müllerian rests with capacity to develop into endometriotic lesions. Müllerianosis was explained as a different disease mimicking endometriosis [5]. Other authors have also speculated about endometriosis arising from coelomic metaplasia [6].

R. Fernandes (✉) · K. Afors
ICESP, University of São Paulo, São Paulo, SP, Brazil

A. Wattiez
Department of Gynecology, Latifa Hospital, Dubai, UAE

University of Strasbourg, Strasbourg, France

G. G. Gomes-da-Silveira et al. (eds.), *Minimally Invasive Gynecology*,
https://doi.org/10.1007/978-3-319-72592-5_9

- Although Sampson's hypothesis remains the most accepted theory, researchers later discovered that 90–95% of women were found to have retrograde menstruation. This raised questions about the theory itself, implying that other factors similarly involved were playing a greater role. Studies have demonstrated a variety of changes mediated by interleukins resulting in a pro-inflammatory environment with neoangiogenesis, endometrial tissue growth, and invasion and inactivation of T and natural killer (NK) cells [6, 7]. As a result, the immune system is unable to eliminate these modified endometriosis cells, thus resulting in tissue proliferation spreading throughout the abdominal cavity. The combination of Sampson's theory together with immunogenic features could indicate why most women have retrograde menstruation but only some develop endometriosis.
- Deep endometriosis is defined as implants infiltrating the peritoneum at a depth of greater than 5 mm. Three types of deep endometriosis have been suggested during the last decades: type 1 conical suggesting infiltration, type 2 deep and covered by adhesions, and type 3 consisting of spherical implants with the largest diameter of disease lying under the peritoneum [8]. Typically type 1 lesions are present and surgically less complicated to remove. Type 2 and 3 lesions are normally unique to the rectum and bladder, but rare cases of two to three nodules may occur. These implants are typically encountered in the pelvis but have been reported in the liver and lungs with even brain dissemination. Besides dissemination throughout the pelvic peritoneum, implants are often found affecting the ovaries, tubes, and uterosacral ligaments. More aggressive cases of endometriosis can affect the digestive, urinary, and neural systems leading to more complex and extensive surgeries often effecting organ function.
- For some time, authors have tried to establish a universal classification of endometriosis matching distribution of the disease with infertility and degrees of pain. Unfortunately to date, none of these propositions are comprehensive. The most recognized classification is based on a publication of the American Society for Reproductive Medicine, where endometriosis distribution is divided into four stages according to complexity: minimal (I), mild (II), moderate (III), and severe (IV) [9].

Epidemiology

- Endometriosis is estimated to effect around 6–10% of women of reproductive age [1]. Most women report symptoms of varying degrees of pain; however, 5% of patients remain asymptomatic. Among patients with infertility, 50% are found to have some degree of endometriosis [10]. In the last few decades, an increase in the prevalence of severe endometriosis has been observed. It remains a subject of debate; however, this increase in prevalence may be attributed to improved diagnosis and greater awareness among both medical practitioners and members of the public [1]. Bowel endometriosis has been reported to affect 8–12% of all patients, and in 90% of cases, the rectum and sigmoid colon are typically involved [5, 11].
- Endometriosis can have a negative impact on women's health and quality of life often affecting personal relationships as well as leading to absenteeism at work [2]. Contributing healthcare costs are also considerable; direct and indirect costs can vary greatly depending on the country and public health system. Direct costs were estimated to range from U$ 1109 up to U$ 12,118 and indirect costs from U$ 3314 up to U$ 15,737 [12, 13].

Symptoms

- Five percent of endometriosis patients remain asymptomatic. The remaining present with a variety of typical and atypical symptoms. Typical symptoms consist of dyspareunia, dyschesia, dysuria, dysmenorrhea, chronic

pelvic pain, and constipation, which can be used to map the disease allowing surgery to be tailored accordingly. These symptoms can be severe and can significantly impact on women's social life, work, personal relationships, and psychological well-being [14]. Dyspareunia is a common symptom affecting 32–70% of women with endometriosis. It is typically found in conjunction with rectovaginal and uterosacral nodules and can lead to significant pain during intercourse. These patients can present with reduced libido, lack of lubrication, and tension on the perineal muscles, all of which can contribute to pain and a negative experience of sexual intercourse. Dysmenorrhea can be a characteristic for the presence of adenomyosis and can be related to endometriomas. Dysuria is rare but may suggest a nodule involving the urinary tract, more commonly the bladder. Nodules affecting the ureters are largely asymptomatic and can lead to silent kidney loss in advanced cases. Dyschesia while not pathognomonic for intestinal tract involvement can be suggestive of the presence of disease located near the bowel [15]. Constipation is not typically associated with endometriosis but it can often coexist. Urinary and bowel dysfunction can be difficult to diagnose preoperatively. In some cases, urodynamics can be useful in diagnosing underlying bladder dysfunction and can be useful in preoperative counseling of patients while also providing documented evidence in the event of medicolegal dispute [16, 17].

- Chronic painful symptoms encountered in endometriosis can have a compensatory effect on pelvic floor muscle contractions. With time, continuous muscle spasms may themselves contribute to the origin of pain. Careful evaluation of the pelvis may result in the identification of specific trigger points. An evaluation of patients with chronic pelvic pain revealed the presence of trigger points in 58.3% compared to 4.2% in healthy women [18]. Patients with ongoing symptoms of pelvic pain following surgery may benefit from physiotherapy treatment.

Infertility

- Infertility is a matter of preoccupation for all women wishing to conceive [19]. Every year more and more women in developed countries choose to postpone their pregnancies for both social- and work-related reasons. Both age-related infertility and other causes can further impact on fertility and can lead to difficulties conceiving. To date, many causes of infertility have been identified; however, approximately 25% of women continue to suffer from unexplained infertility.
- The link between endometriosis and infertility remains controversial, and the exact etiology is poorly understood. It is the most common disease found in infertile patients, with endometriosis reported in up to 50% of women with infertility. In addition, women with endometriosis have a twofold greater risk of infertility compared to those without [20]. The causal effect of the disease process on infertility is yet to be identified. Stage IV disease is typically associated with distorted anatomy and dense adhesions, which can affect natural conception. Reduced embryo and oocyte quality, in addition to peritoneal inflammation, may also impact on fertility. It is still unclear whether severity of disease has a progressive association on infertility.
- Endometriosis cysts or so-called endometriomas have been the source of much discussion among surgeons and fertility specialists alike. Fertility specialists are often adamant to emphasize the potential negative impact of endometrioma surgery on ovarian reserves, due to the inadvertent removal of healthy tissue during ovarian stripping. For these reasons fertility experts often recommend a more conservative approach to the management of endometriomas, specifically in unilateral disease with endometriomas less than 3–4 cm in size. Some studies have found lower pregnancy rates and live birth rates, in addition to higher gonadotrophin requirements and need for longer ovarian stimulation in patients with a previous history of cystectomy, despite a

similar number of retrieved oocytes compared to the noncystectomy group [21]. Equally, deleterious effects on ovarian function may be a result of poor technique and lack of surgical experience. A meticulous surgical approach with the sparing use of diathermy and careful identification of surgical planes in the hands of an experienced surgeon can optimize ovarian preservation [22–24]. This demonstrates the controversy surrounding infertility in the presence of endometriomas [25, 26]. In addition, it cannot be ignored that in the presence of large endometriomas, specifically bilateral, disease is frequently associated with more extensive pelvic implants. Equally the nonselective use of ART in the presence of large endometriomas may serve as a trigger causing spread of mild endometriosis into more severe disseminated disease, resulting in a more difficult surgical approach [22–24, 27].

Diagnosis

- Accurate diagnosis of endometriosis requires both experience and knowledge of the disease. Patients often consult three to four gynecologists prior to a definitive diagnosis being made. Delay in diagnosis is a common problem worldwide. Developed countries like Germany, Austria, the United Kingdom, and Italy report an overall delay of 7–10 years. Ireland and Belgium report a delay of 4–5 years. In Brazil, diagnosis is delayed by 12.1 years (ranging from 8 to 17.2 years) [28].
- Diagnosis can be divided into clinical and imaging. Symptoms can serve as a useful guide to the clinician, with pain intensity differing from one patient to the next. Dysmenorrhea and dyspareunia are often encountered in the majority of patients. Dysuria, dyschesia, and chronic pelvic pain can also be present and, however, can vary in severity. Symptoms of constipation may not necessarily be related to endometriosis.
- Clinical examination is obligatory and can guide the surgeon as to the complexity of the disease while also prompting specific investigation necessary for a complete preoperative workup. Abdominal palpation can be useful in patients presenting with big endometriomas or even abdominal wall spread. Vaginal examination with a speculum can identify dark cysts of rectovaginal nodules protruding through the posterior cul-de-sac.
- Patient describing pain at the vaginal introitus, in the absence of a palpable nodule, may represent a sign of vaginismus. Deeper evaluation of all fornices can allow for the assessment of bladder nodules anteriorly, uterosacral nodules present at 5 and 7 o'clock, and rectovaginal nodules palpated more centrally. In this case, an acute angle between the nodule and the bowel is less suggestive of bowel invasion, while an obtuse angle represents the opposite. Due to pain experienced during vaginal examination itself, sometimes little information can be retrieved. Examination under anesthesia prior to surgery may provide more clinical information regarding the extent of disease allowing the surgeon to tailor their approach.
- Ultrasound mapping should always be performed as the first-line imaging tool. The method is operator dependent, and results are based on the experience of the individual specialist performing the scan [29]. Ultrasonography should include a complete evaluation of the pelvis including assessment of the renal pelvis, course of the ureters, and verification of whether there is any dilatation of the ureters. Lastly, a detailed analysis of the anterior and posterior cul-de-sac, specifically bowel wall layers, is recommended. This has proved to be a powerful tool in the hands of skilled physicians showing similar results to MRI exams. Mobilization of the probe can also assess for the presence of adhesions.
- Magnetic resonance imaging (MRI) has been reported to have 96.3% of sensibility and 100% of specificity but may vary depending on each evaluated site [29, 30]. The majority of devices use 1.5 Tesla providing good qual-

ity images. Recent use of 3.0 Tesla MRIs creates the possibility of better quality images and, consequently, more accurate diagnosis. Optimal timing for MRI evaluations remains unclear. Some authors advocate that during menstrual period, the uterus may demonstrate pseudo thickening, which can lead to misdiagnosis of adenomyosis [31, 32]. Others suggest that pelvic fluid present either in the periovulatory or menstruation phase can also affect image interpretation. However, most authors recommend a partially empty bladder, in addition to specific bowel preparation with the use of rectal and vaginal gel which provides more information with regard to limits of the pelvic structures [32].

- Irrespective of the benefits of both MRI and ultrasonography, both methods have their drawbacks. Compared to ultrasound, MRI can provide accurate diagnosis of more widespread foci of endometriosis. However, for the assessment of smaller nodules and implants, ultrasound may be more precise. Regardless of the technique or method used, surgeons should be able to retrieve information such as [8]:

- Size of the lesion (longitudinal and transverse measurements)
- Depth of an infiltration of the intestinal wall
- Percentage of the intestinal circumference affected by the disease
- Distance between the intestinal DIE lesion and anal verge
- Presence of multifocal/multicentric intestinal DIE lesion
    - Bladder and bowel dysfunction following surgery is often a preoccupation. Urodynamics and anal manometry are useful tests and might demonstrate subtle changes often not recognized by patients. These changes may be suggestive of endometriosis affecting the inferior hypogastric plexus and its branches warning both the surgeon and the patient about the depth of disease and risk of potential functional impairment [33].

Treatment

- Depending on clinical examination, symptomatology, desire to conceive, and patient's wishes, endometriosis can be treated medically or surgically. Surgery should not always be considered first line, and women should be counseled appropriately regarding different treatment options. Patients can be divided into three main groups. The first group includes patients with few symptoms and no desire to conceive in whom medical treatment would be recommended. The second group includes patients with none or few symptoms but strong desire to conceive. These patients should promptly be referred to fertility specialists for further management. The third group consists of patients with severe pain with or without desire to conceive, with a clinical evaluation suggestive of extensive disease. This cohort is more optimally treated by surgery first. It should be emphasized that removal of disease prior to ovarian stimulation may play a positive role on pregnancy rates in women undergoing fertility treatment [34].
- The final group of patients are not often encountered and typically have minimal symptoms; however, coexisting organ failure such as kidney failure or bowel obstruction is present. These patients require surgery to preserve organ function and avoid severe sequelae.

Surgical Treatment

- The main objective of surgical treatment is to remove implants of endometriosis situated within the abdominal cavity. There continues to be much debate as to whether to ablate or excise disease present; this should be considered in the context of severity of disease, patient symptoms and wishes, as well as expertise of the surgeon. There are both general and specific approaches to the surgical management of endometriosis, which have

been reported by our group [35]. Patients should be limited to a minimal number of surgeries considering that repeat procedures are associated with greater risk of adhesion formation and fibrosis making additional surgery more challenging [36].

Peritoneal Endometriosis

- Peritoneal endometriosis is one of the trending topics nowadays. Superficial lesions were once been described as nonprogressive, typically undergoing self-limiting apoptosis. In theory, removing these spots should provoke scar formation as a result of the surgical intervention, causing permanent fibrosis. However, there is still no evidence as to which kind of lesion undergoes apoptosis or not [37]. Pain is usually related to deeper lesions as a result of intense inflammation, increased neural terminations, adhesions, or retraction [38]. Superficial lesions can also cause pain caused by imbalance in nerve fibers [39]. Some authors have demonstrated that even these small lesions may be responsible for significant painful symptoms. For this reason, emphasis is placed on the initial surgical intervention being conducted by an experienced surgical team with the specific skills to remove all disease while minimizing adhesion formation [36] (Fig. 9.1).

Ovarian Endometriosis

- Ovarian endometriosis is present in 22% of infertile women [35]. It can be accountable for symptoms of infertility, and thus, follicle evaluation and anti-Müllerian hormone should be included in preoperative investigations. Asymptomatic cysts less than 3–4 cm in size, found during routine examination, can be followed up with regular ultrasound. Management of larger endometriosis cysts incidentally found on ultrasound, on MRI, or during laparoscopy represents an endless discussion whether they should be completely removed or not due to the supposed damage to the ovarian reserve. Infertility experts defend cyst drainage with vaporization of the cyst wall, advocating minimal additional damage to surrounding normal ovarian tissue. Some surgeons defend the use of plasma jet or CO_2 laser ablation of the cyst capsule in order to minimize damage to normal ovarian tissue. Laparoscopic treatment consists of cyst drainage and vaporization with bipolar when less than 3–4 cm in size. For bigger cysts, inversion of the ovary facilitates stripping of the capsule. Precise technique with identification and dissection of the cleavage plane causes limited bleeding to the capsule, thereby limiting damage. There are pros and cons associated with both surgical approaches. Ablative

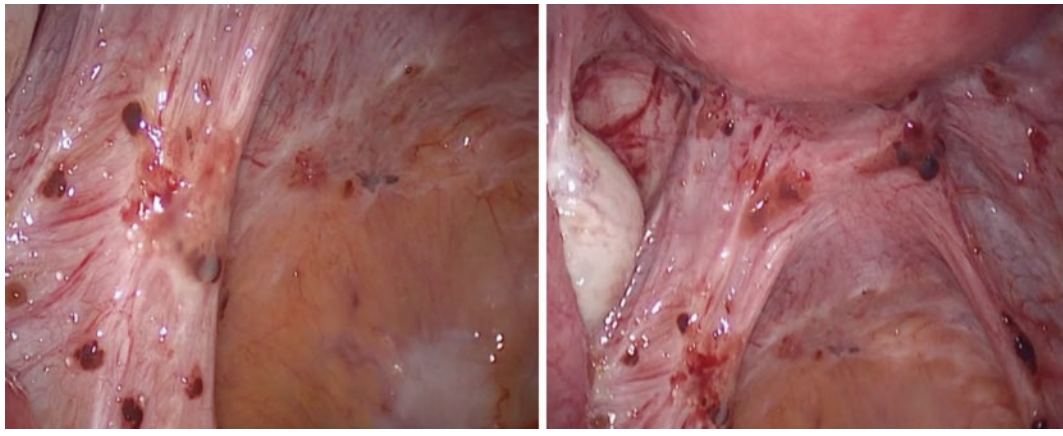


Fig. 9.1 Superficial endometriotic lesions

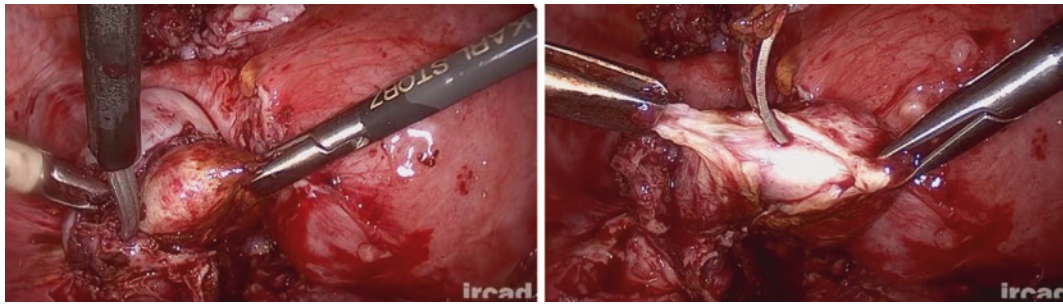


Fig. 9.2 Endometrioma stripping technique

techniques can lead to recurrent disease requiring additional surgery. In the long term, this could cause more damage to the ovarian reserve [40]. Equally, precise and careful stripping of the cyst wall is technically more challenging and can negatively impact on ovarian reserve but is associated with a lower rate of recurrence when performed by experienced surgeons (Fig. 9.2).

Posterior Cul-De-Sac

- The majority of cases of deep endometriosis involving the posterior cul-de-sac typically consists of ovaries attached to the ovarian fossa and uterosacral ligaments. Depending on the extent and severity of disease, it can extend to involve the vaginal wall, the ureters, the rectovaginal septum, and bowel. Surgeons expected to treat complex endometriosis must be aware that, even with good preoperative workup, the true extent of disease may be unexpected, making surgery more challenging. Surgical management of deep endometriosis can be both demanding and difficult and requires expertise in dissection, electrosurgery, transversal competences, and management of complications during and after surgery. Endometriotic nodules can often mimic icebergs, appearing on the surface as superficial disease, while deep nodules infiltrating surrounding tissue lie concealed. Strategy consists of identifying and normalizing anatomy and isolating the nodule from surrounding structures. For example, for simple uterosacral nodule dissection, one should be aware of the superficial hypogastric nerves, uterine vessels, ureters, and also bowel wall, even if not directly infiltrating these organs [35]. Ureters are often medialized due to the presence of adhesions. Dissection might reach the posterior aspect of the paracervix which can result in damage to uterine vessels, highlighting the need for precise coagulation. In the same manner, the underlying nerve plexus may be trapped within the disease requiring the surgeon to carefully consider whether to excise the disease and risk damage to the innervation or leave it in place in order to preserve bladder and bowel function [41].
- The frozen pelvis as a result of adhesion formation results in severe distortion of the anatomy. They can be caused by multiple adhesions due to repetitive surgeries, pelvic inflammatory disease, or stage IV endometriosis. A standardized strategic approach to a frozen pelvis starts with identification and understanding of the anatomical distortion with recognition of key anatomical landmarks, followed by adequate exposure of the surgical field. Dissection should start on the left pelvic side wall with identification of the IP ligaments and the left ureter followed by dissection of the left pararectal fossa down to the uterosacral ligaments avoiding injury to the inferior hypogastric nerve. The ovaries are freed, and endometriomas if present are decompressed and suspended to the anterior abdominal wall if necessary. The same technique is repeated on the right side trying to isolate the bowel attachment and nodule.

These gestures diminish the amount of uncertainty when detaching the bowel nodule from the cervix/vagina. Further evaluation of the bowel should be performed to decide which specific surgical approach should be adopted.

Vaginal Endometriosis

- Nodules on the posterior cul-de-sac are often related to dyspareunia (Chapron). Vaginal nodules lie in close relationship with the torus uterus, paracervix, ureters, and bowel and should be excised with extreme caution. Deep nodules may represent full-thickness disease of the vaginal wall and can be palpated on digital examination of the posterior compartment of the vagina. Frequently, during dissection, the surgeon much addresses large nodules attaching the vagina to the rectosigmoid. Associated digital vaginal examination and cranial traction of the sigmoid by the assistant help to guide the surgeon and identify the anatomical limits of these different organs. Superficial excision of these nodules can be achieved in some cases avoiding vaginal wall opening. If the depth of nodule infiltration compels the surgeon to open the vagina, this defect should be closed with monofilament sutures to avoid granulomas and further dyspareunia. Adenomyomas of the uterine torus with extension to the vagina demand extreme expertise due to their close proximity to the cervical canal and associated risk of stenosis (Fig. 9.3).

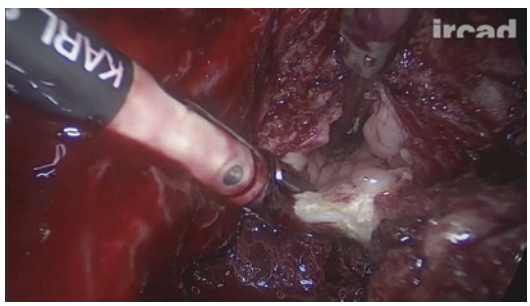


Fig. 9.3 Open vagina demonstrating nodule affecting the complete deepness of the vagina

Bowel Endometriosis

- Bowel endometriosis is only considered when it infiltrates the muscular layer [42]. Although simple attachments and serosal involvement are not incorporated into this classification, careful dissection of the surrounding structures and specific evaluation of the bowel are essential so as not to leave residual disease behind. Nodules are typically solitary accounting for 60–70% of the cases. Multifocal bowel endometriosis is defined as nodules greater than 2 cm in diameter, with multiple foci of nodules exist located greater than 2 cm from one another [43]. Treatment should be individualized and balanced according to the patient's desire, symptomatology, size of the nodule, lumen stenosis, and risk of possible complications.
- Initially bowel surgery performed by colorectal surgeons resulted in long segments of bowel resections due to adopting a radical oncology type approach to surgery. As practice evolved, in conjunction with greater experience and understanding by gynecologists, the way of managing the disease made more economical approaches possible. Bowel shaving, as the name suggests, describes specific excision of disease from the bowel wall where a variety of instruments can be used (cold scissors, monopolar energy, plasma jet, laser, etc.). Mucosal skinning is a variation of this technique when ablation of the disease only spares the mucosa. Depending on the result and damage of the muscular, reinforcement with sutures may be necessary. Discoid resections consist of full-thickness resection of the anterior bowel wall. It is indicated when the disease compromises the entire bowel wall until the mucosa; however, its size is limited to a maximum of 3 cm in diameter. It is a fast and simple procedure, with low rate of complications. Rectal bleeding following discoid resection has been reported in the literature and may be the result of lateral mesosigmoid vessels becoming trapped into the edges of the resection margins.
- Whether a radical approach should be adopted ensuring complete excision of all endometrio-

sis cells and evidence of disease with clear resection margins has been the matter of much debate. It is important to emphasize that this is not a malignant disease with some research suggesting death of the surrounding cells when the main bulk of disease is resected [44]. It is important to consider that more economical resections result in fewer functional complications [37]. Extensive dissections can cause damage to the inferior hypogastric plexus and neural terminations leading to permanent damage and functional problems.

Shaving

- Lesions affecting the superficial layers of the sigmoid rectum can be treated using "shaving" technique. After isolating the specific lesion, the bowel wall is incised, and the disease is peeled off separating it from the bowel. Once excision is complete, the remaining defect is assessed, and depending on the depth and size of the shaved rectal wall, reinforcement of the wall with an overlaying suture or even an anterior discoid stapling may be indicated. A careful reevaluation of the remaining suture or stapling line is mandatory. In the presence of extensive "shaving," if the remaining bowel wall appears fragile and friable after suturing or substantial residual disease left behind, the surgeon should consider a segmental resection [45] (Fig. 9.4).

Discoid Resection

- Discoid resection is considered a simple, reliable, low-morbidity, and reproducible method. The technique is based on an anterior discoid resection of the bowel wall. The circular stapler connected to the anvil is introduced through the anus up to the level of the disease. The system is opened, and with a sutured attached to the lesion, the surgeon pushes the nodule inside the system. With an anterior orientation, the second assistant closes the anvil shooting the system with the nodule inside. Careful retraction of the stapler is needed not to cause tension on the stapling line. Limitations mainly include diameter, volume, and location of the disease, in addition to high lesions that are impossible to reach with the circular stapler. Nodules greater than 3–3.5 cm are considered too large for this type of approach [46].
- For bulky nodules an interesting option is to combine the shaving technique with a discoid resection. Excising the greater part of the nodule makes the bowel wall thinner, enabling it to fit inside the anvil (Fig. 9.5).

Segmental Resection

- Advanced bowel endometriosis usually presents with large, extensive, and multifocal disease. Individual excision of these nodules might leave the bowel wall fragile, extremely angulated, or even stenotic. Nevertheless, segmental bowel resections in deep endometriosis should maintain an economical approach to treatment [35]. The majority of nodules affecting the bowel wall can be found attached to the posterior aspect of the uterus. After development of both pararectal fossae and detachment of the bowel from the torus, the surgeon should identify the cranial and caudal limits of the dis-

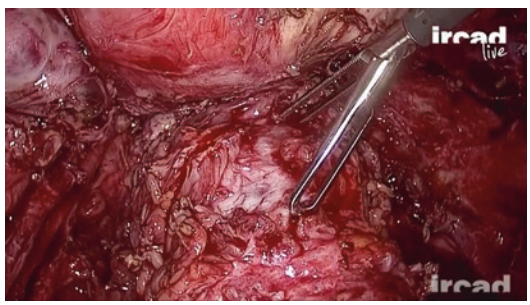


Fig. 9.4 Shaving of the rectal wall demonstrating

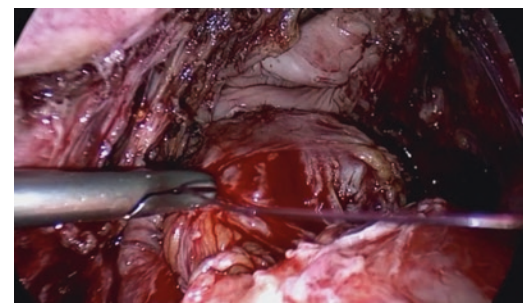


Fig. 9.5 Anterior rectal wall disc excision

ease bowel segment [47]. The mesosigmoid should be divided close to the bowel wall internal to the fascia propria of the rectum, thus sparing innervation and vascularization of the bowel. The caudal limit of the bowel segment is divided by means of a linear staple, with exteriorization of the proximal part through a suprapubic incision. Extracorporeally, the diseased bowel segment is divided above the nodule; the anvil is introduced through this proximal segment and secured with a purse string suture. After resection of the diseased segment, the bowel is reintroduced into the abdominal cavity; a circular stapler is introduced in the rectum and both proximal and terminal extremities of the rectum reconnected. When firing the stapler, the surgeon should maintain the orientation of the bowel, making sure no surrounding structures are trapped between the anvil and the circular stapler (Fig. 9.6).

Natural Orifice Specimen Extractions (NOSE)

- Natural orifice specimen extractions in endometriosis are feasible but logistically complex. Vaginal and anal extractions have been tested with excellent results and low morbidity. These techniques require longer length of the bowel to be mobilized and exteriorized through the anus, requiring more mesosigmoid to be divided, increasing the risk of compromising innervation and vascularization of the bowel [48].
- The fact that two suture lines lie in close proximity to one another can raise the risk of fistula formation. Vaginal NOSE should be only considered if the anvil can be introduced proximal to the lesion transanally. The bowel is divided caudal to the lesion and extracted through the vagina. The anvil, attached to a long suture, is introduced through a small incision and retrogradely displaced high in the sigmoid colon. Then the proximal segment of the bowel is divided cranial to the nodule with a laparoscopic stapler. The suture attached to the anvil is caught in the staple line. The specimen is extracted through the vagina and the anvil connected to the circular stapler reconstituting the anatomy of the bowel [49] (Fig. 9.7).

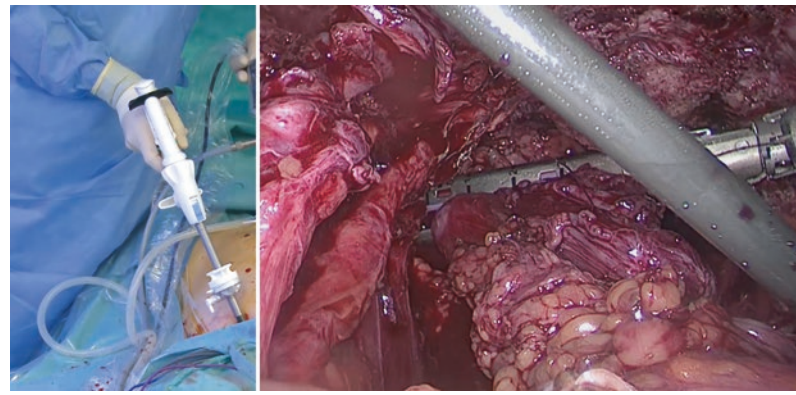


Fig. 9.6 Segmental bowel resection for rectal endometriosis nodule

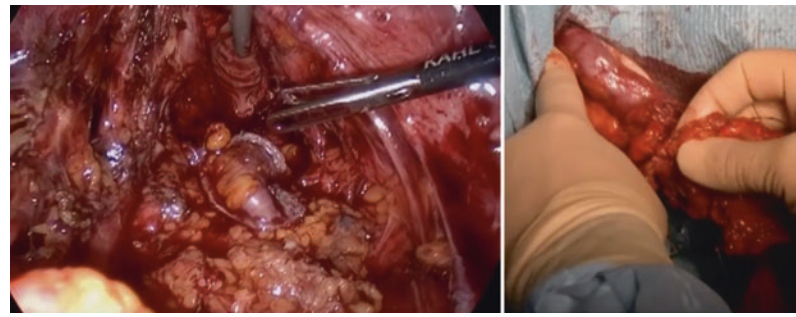
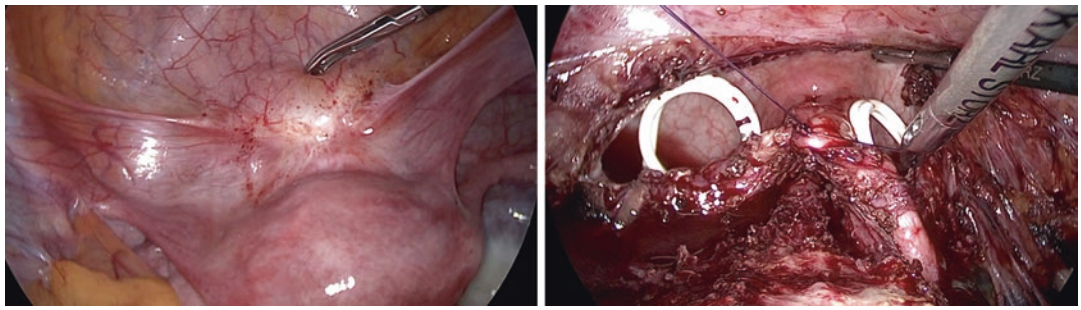


Fig. 9.7 Vaginal NOSE

- Anal extraction is logistically more complex and demands a close collaboration among surgeons. A loop is placed below from the nodule and the rectosigmoid transected. After exteriorization, the anvil is introduced through the transected extremity attached to a long thread and pushed cranially. The rectum is once again divided cranially to the area of disease and reintroduced in the cavity. Once inside, the tip of the anvil is exteriorized through the rectosigmoid wall by fishing out the suture. The tip is removed and the anvil attached to the circular stapler. Once the reanastomosis is complete, the integrity of the anastomosis is tested by means of a gas and methylene blue safety. If positive, a reinforcement of the wall can be performed with sutures.
- Extensive manipulation of an open bowel wall has triggered discussions surrounding the morbidity related to bacterial contamination. Studies have shown that despite higher contamination, clinical outcomes were similar to those submitted to standard approach [50].

Urinary Endometriosis

- Endometriosis affects the urinary tract in 1–5% of all patients. The bladder and ureter are, by far, the most commonly affected structures, while disease involving the kidney and urethra are rare. The ratio between both bladder and ureter involvements is approximately 8:1 making the bladder the most affected organ of the urinary tract [51].
- Bladder endometriosis can be divided into superficial and deep nodules. Superficial nodules are often identified at surgery, and women typically remain asymptomatic. Deep nodules, however, typically invade the detrusor muscle greater than 5 mm in depth. The majority of nodules are distributed centrally, situated mainly at the bladder dome. Disease involving the trigone is less commonly encountered and is perhaps suggestive of disease dissemination from adenomyosis arising from the myometrium. Symptoms are more frequently encountered in deep infiltrating nodules and may include monthly dysuria, polyuria, tenesmus, and hematuria. Symptoms may temporarily be relieved with hormonal treatment; however, if discontinued, they often recur.
- Laparoscopic partial cystectomy is considered to be the gold standard of treatment. Complete removal of the disease often alleviates symptoms with little risk of relapse. Endometriosis involving the trigone is a complex disease due to the proximity of the ureter and risk of damage to bladder innervation. A structured surgical technique should be adopted. Analogs can be considered to decrease the size of the nodule, thereby increasing the distance of disease from the ureter. If nodules include the ureteral ostium, reimplantation may be required. Bladder closure can be performed using interrupted or continuous sutures in one or two layers. In our practice, we typically use monofilament. Postoperatively, the bladder should be rested by means of an indwelling urethral catheter for at least 10 days, allowing the bladder to heal and inflammation to resolve (Fig. 9.8).



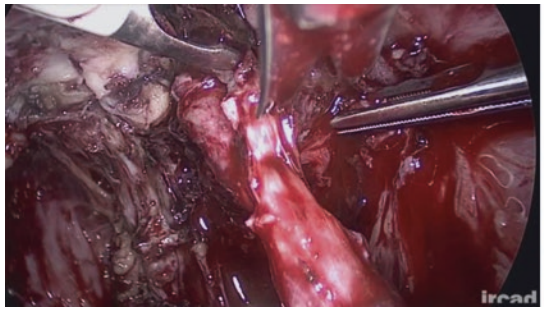
1. During inspection 2. During bladder suture

Fig. 9.8 Bladder endometriosis nodule

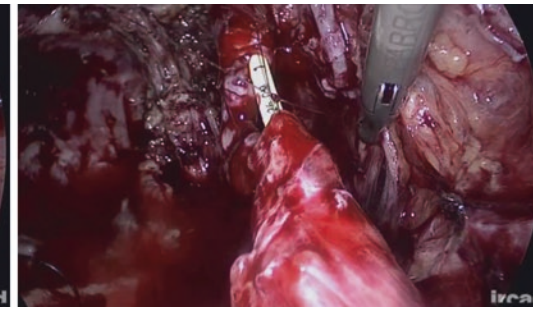
- While bladder nodules more often occur in isolation, ureteral disease is frequently associated with endometriosis involving the posterior cul-de-sac. Disease involving the left ureter is more frequent encountered, but bilateral disease is reported in 5–23% of cases. Extrinsic endometriosis surrounds the ureter and represents 70–80% of ureteral involvement. Intrinsic disease infiltrates the muscular or mucosa wall and accounts for 20–30% of cases. Specific symptoms are vague, occur in 70% of cases, and can include renal colic and pyelonephritis [51]. Silent renal loss is the most concerning complication in urinary endometriosis and may occur in up to 30% of cases. Preoperative workup may includes ultrasound, uroCT, and uroMRI that can be performed if deemed necessary. Ureteric stenting may be indicated prior to surgery depending on the clinical history. Severity of the disease will dictate surgical management of ureteric endometriosis. Ureterolysis in isolation can be performed when there is no intrinsic disease and the ureter is easily dissected. Intrinsic and/or extensive involvement may require resection of the diseased segment and subsequent end-to-end reanastomosis. If following removal of disease there is insufficient remaining length of the ureter, a primary end-to-end anastomosis is impossible, and a psoas hitch may be needed [53]. Do not speak about Boari flap because it is poorly indicated in this benign disease (Fig. 9.9).

Postoperative Care

- Surgery for complex cases of endometriosis requires a team of experts with extensive knowledge of anatomy, understanding of transversal competencies, and meticulous attention to postoperative care. Daily, incremental improvements in the overall patient's clinical state should be observed, and any deterioration in the clinical picture should raise suspicion of a complication, and an early second look laparoscopy should be considered. Simple endometriosis cases can be discharged on the same day. More complex cases with bowel or urinary tract involvement may require hospitalization for 2–7 days. Antibiotics can be administered as a single dose when the vagina is opened or continued for 7 days if the bowel wall is breached [1]. At present, there are no specific blood tests to identify complications and guide an early second-look laparoscopy. C-reactive protein is a serum marker of inflammatory activity and tends to drop daily after surgery. Use of silicon drain depends on individual practice and experience of each surgical group. There is insufficient evidence to advocate the use of routine pelvic drainage; however, some clinicians may find it helpful in deciding on a second look and as an early detector of anastomotic leaks.
- The inferior hypogastric plexus is responsible for bowel, bladder, vagina, and uterus innervation [54]. Big endometriotic nodules, espe-



1. Ureterolysis of the ureter



2. End to end anastomosis

Fig. 9.9 Ureter endometriosis

cially those which invade the deep lateral aspects of pararectal fossae, might be damaged from endometriosis or from dissection [38]. Damage can reach every single part of the plexus but the most affected organ is the bladder [41]. If mostly sympathetic fibers are affected, patients may suffer from urgency and incontinence. If the parasympathetic fibers are involved, the bladder fails to contract appropriately resulting in incomplete voiding difficulties. These symptoms are typically transient and often resolve after weeks or months. Symptoms lasting for greater than 1.5 years have a greater risk of remaining permanent [55].

Complications

Surgical excision of deep endometriosis is both demanding and requires a high degree of expertise due to the involvement of surrounding structures such as the vagina, ureters, and bowel. While complete excision has been shown to control symptoms and reduce the rate of recurrence, radicality of surgery must be balanced against the risk of complications. Complication rates in endometriosis surgeries tend to be higher than in other gynecological procedures and should be performed by a competent, experienced surgeon in a specialist center in order to achieve acceptable complication rates. The complexity of endometriosis surgery and risk of associated complications can be attributed to the disease itself. Structures tend to be densely adherent to one another, making it difficult to distinguish and dissect organs from surrounding structures such as vessels and nerves. Overall complications rates associated with endometriosis surgery are reported to be around 10.2% but can increase depending on severity of disease and specific organ involvement [56].

The rate of complications associated with excision of bladder nodules is often low. The majority of nodules are located at the dome of the bladder, far away from the trigone. In 22 cases reported by Kovoor et al., major complications were mainly related to concomitant bowel procedures. No intraoperative injuries were reported. Postoperative complications included two hematomas requiring transfusion and re-intervention and two vesicovaginal fistulas, one treated by laparoscopy and the other conservatively by means of an indwelling catheter for 15 days [52].

Ureteric injuries are often associated with rectovaginal nodules due to the presence of fibrosis and retraction resulting in medialization of the ureter with dense disease often surrounding the ureter. In 198 cases of ureteral endometriosis, Alves et al. reported 28 cases of hydronephrosis, where 15 ureterolyses, 12 reanastomoses, and 1 reimplantation were performed. Of these, three patients (10.7%) required further surgical management for treatment of ureterovaginal fistula, persistent pain, and ureteral dilatation [53].

Complications related to specific bowel involvement are more common and are associated with significant morbidity. Pandis reported 8.5% of complications when shaving; discoid and segmental resections were performed. Four patients were readmitted, two with pelvic hematoma, of whom only one required further surgical intervention. Of the other two, one presented with constipation and the other with rectal hemorrhage [56]. Ruffo et al. in 2012 reviewed 750 cases of mid-low rectum resection. Reoperation was necessary in 5.5% (40 patients). Anastomotic leakage was found in 3% (21 patients). Sixteen patients (2%) developed rectovaginal fistula, only two treated conservatively [57]. Another review from Kondo in 2010 reported 12 (2.1%) intraoperative complications including 2 ureteral lesions and 2 small bowel lesions [58]. Seventy-nine women (13.9%) presented with postoperative complications including eight cases of rectovaginal fistula, six ureteral fistula, two ureteral stenosis, and one ureterovaginal fistula. Donnez et al. in a series of 500 rectal shavings reported rectal perforation in 7 patients (1.4%) and 4 cases (0.8%) of urinary retention [59]. When evaluating functional outcomes in 41 patients, Roman et al. reported a higher rate or bowel dysfunction in patients who underwent segmental bowel resection when compared to economical nodule excision. Three patients from the segmental resection group reported severe constipation [17, 41].

Conclusion

Endometriosis is a complex, challenging, enigmatic disease. The true pathophysiology of this unique disease is yet to be elucidated. What should remain at the forefront of discussion when contemplating surgical management is to individualize treatment according to patient symptoms and disease localization. Endometriosis appears to be on the increase part of which may be attributed to greater awareness of the disease process within the public domain. Nevertheless, delay in diagnosis remains a reality due to lack of knowledge related to often subtle, nonspecific symptoms often overlooked by general practitioners. Ultrasound mapping and MRI are powerful tools in diagnosis but are dependent on interpretation by experienced operators and radiologists. Medical treatment is useful at initial stages of disease but should also be considered as an adjuvant in the presence of deep lesions or long-term infertility. Laparoscopic treatment of endometriosis is still considered the gold standard with enormous benefits, and its use should be encouraged and disseminated.

References

1. Koninckx PR, Ussia A, Adamyan L, Wattiez A, Donnez J. Deep endometriosis: definition, diagnosis, and treatment. Fertil Steril. 2012;98(3):564–71.
2. Studio dell'Endometriosi lo GIP. Prevalence and anatomical distribution of endometriosis in women with selected gynaecological conditions: results from a multicentric Italian study. Gruppo italiano per lo studio dell'endometriosi. Hum Reprod. 1994;9(6):1158–62.
3. Sherif AM, Musa ER, Kedar R, Fu L. Subcapsular hepatic endometriosis: case report and review of the literature. Radiol Case Rep. 2016;11(4):303–8.
4. Sampson JA. Metastatic or embolic endometriosis, due to the menstrual dissemination of endometrial tissue into the venous circulation. Am J Pathol. 1927;3(2):93–110.43.
5. Batt RE, Smith RA, Buck Louis GM, Martin DC, Chapron C, Koninckx PR, et al. Müllerianosis. Histol Histopathol. 2007;22(10):1161–6.
6. Abrao MS, Muzii L, Marana R. Anatomical causes of female infertility and their management. Int J Gynaecol Obstet. 2013;123(S2):S18–24.
7. Yu J-J, Sun H-T, Zhang Z-F, Shi R-X, Liu L-B, Shang W-Q, et al. IL15 promotes growth and invasion of endometrial stromal cells and inhibits killing activity of NK cells in endometriosis. Reproduction. 2016;152(2):151–60.
8. Trippia CH, Zomer MT, Terazaki CRT, Martin RLS, Ribeiro R, Kondo W. Relevance of imaging examinations in the surgical planning of patients with bowel endometriosis. Clin Med Insights Reprod Health. 2016;10:1–8.
9. ASRM. Revised American Society for Reproductive Medicine classification of endometriosis: 1996. Fertil Steril. 1997;67(5):817–21.
10. Dunselman GAJ, Vermeulen N, Becker C, Calhaz-Jorge C, D'Hooghe T, De Bie B, et al. ESHRE guideline: management of women with endometriosis. Hum Reprod. 2014;29:400–12.
11. Akladios C, Faller E, Afors K, Puga M, Albornoz J, Redondo C, et al. Totally laparoscopic intracorporeal anastomosis with Natural Orifice Specimen Extraction (NOSE) techniques, particularly suitable for bowel endometriosis. J Minim Invasive Gynecol. 2014;21(6):1–24.
12. Simoens S, Dunselman G, Dirksen C, Hummelshoj L, Bokor A, Brandes I, et al. The burden of endometriosis: costs and quality of life of women with endometriosis and treated in referral centres. Hum Reprod. 2012;27(5):1292–9.
13. Soliman AM, Yang H, EX D, Kelley C, Winkel C. The direct and indirect costs associated with endometriosis: a systematic literature review. Hum Reprod. 2016;31(4):712–22.
14. De Graaff AA, Van Lankveld J, Smits LJ, Van Beek JJ, Dunselman GAJ. Dyspareunia and depressive symptoms are associated with impaired sexual functioning in women with endometriosis, whereas sexual functioning in their male partners is not affected. Hum Reprod. 2016;31(11):2577–86.
15. Renner SP, Boosz AS, Burghaus S, Maihöfner C, Beckmann MW, Fasching PA, et al. Visual pain mapping in endometriosis. Arch Gynecol Obstet. 2012;286(3):687–93.
16. Rozsnyai F, Roman H, Resch B, Dugardin F, Berrocal J, Descargues G, et al. Outcomes of surgical management of deep infiltrating endometriosis of the ureter and urinary bladder. JSLS. 2011;15(4):439–47.
17. Roman H, Loisel C, Resch B, Tuech JJ, Hochain P, Leroi AM, et al. Delayed functional outcomes associated with surgical management of deep rectovaginal endometriosis with rectal involvement: giving patients an informed choice. Hum Reprod. 2010;25(4):890–9.
18. Bispo Dos APS, Ploger C, Loureiro AF, Sato H, Kolpeman A, Girão MJBC, et al. Assessment of pelvic floor muscles in women with deep endometriosis. Arch Gynecol Obstet. 2016;294(3):519–23.
19. Somigliana E, Paffoni A, Busnelli A, Filippi F, Pagliardini L, Vigano P, et al. Age-related infertility and unexplained infertility: an intricate clinical dilemma. Hum Reprod. 2016;31(7):1390–6.

20. Prescott J, Farland LV, Tobias DK, Gaskins AJ, Spiegelman D, Chavarro JE, et al. A prospective cohort study of endometriosis and subsequent risk of infertility. Hum Reprod. 2016;31(7):1475–82.
21. Roustan A, Perrin J, Debals-Gonthier M, Paulmyer-Lacroix O, Agostini A, Courbiere B. Surgical diminished ovarian reserve after endometrioma cystectomy versus idiopathic DOR: comparison of in vitro fertilization outcome. Hum Reprod. 2015;30(4):840–7.
22. Witz CA, Burns WN. Endometriosis and infertility: is there a cause and effect relationship? Gynecol Obstet Investig. 2002;53(Suppl 1):2–11.
23. Witz CA, Allsup KT, Montoya-Rodriguez IA, Vaughan SL, Centonze VE, Schenken RS. Pathogenesis of endometriosis--current research. Hum Fertil (Camb). 2003;6(1):34–40.
24. Santulli P, Lamau MC, Marcellin L, Gayet V, Marzouk P, Borghese B, et al. Endometriosis-related infertility: ovarian endometrioma per se is not associated with presentation for infertility. Hum Reprod. 2016;31(8):1765–75.
25. Muzii L, Achilli C, Bergamini V, Candiani M, Garavaglia E, Lazzeri L, et al. Comparison between the stripping technique and the combined excisional/ablative technique for the treatment of bilateral ovarian endometriomas: a multicentre RCT. Hum Reprod. 2015;31(2):339–44.
26. Ata B, Urman B. Endometrioma excision and ovarian reserve; do assessments by antral follicle count and anti-Müllerian hormone yield contradictory results? Hum Reprod. 2014;29(12):2852–4.
27. Centini G, Afors K, Murtada R, Argay IM, Lazzeri L, Akladios CY, et al. Impact of laparoscopic surgical management of deep endometriosis on pregnancy rate. J Minim Invasive Gynecol. 2016;23(1):113–9.
28. Santos TMV, Pereira AMG, Lopes RGC, Depes DDB. Lag time between onset of symptoms and diagnosis of endometriosis. Einstein (São Paulo). 2012;10(1):39–43.
29. Abrao MS, Goncalves MODC, Dias JA, Podgaec S, Chamie LP, Blasbalg R. Comparison between clinical examination, transvaginal sonography and magnetic resonance imaging for the diagnosis of deep endometriosis. Hum Reprod. 2007;22(12):3092–7.
30. Hottat N, Larrousse C, Anaf V, Noel J-C, Matos C, Absil J, et al. Endometriosis: contribution of 3.0-T pelvic MR imaging in preoperative assessment--initial results. Radiology. 2009;253(1):126–34.
31. Manganaro L, Vittori G, Vinci V, Fierro F, Tomei A, Lodise P, et al. Beyond laparoscopy: 3-T magnetic resonance imaging in the evaluation of posterior cul-de-sac obliteration. Magnetic Resonance Imaging. 2012;30(10):1432–8.
32. Bazot M, Bharwani N, Huchon C, Kinkel K, Cunha TM, Guerra A, et al. European society of urogenital radiology (ESUR) guidelines: MR imaging of pelvic endometriosis. Eur Radiol. 27(7):2765–75.
33. Spagnolo E, Zannoni L, Raimondo D, Ferrini G, Mabrouk M, Benfenati A, et al. Urodynamic evaluation and anorectal manometry pre- and post-operative bowel shaving surgical procedure for posterior deep infiltrating endometriosis: a pilot study. J Minim Invasive Gynecol. 2014;21(6):1080–5.
34. Centini G, Afors K, Murtada R, Argay IM, Lazzeri L, Akladios CY, et al. The impact of laparoscopic surgical management of deep endometriosis on pregnancy rate. J Minim Invasive Gynecol. 2015;23(1):1–26.
35. Wattiez A, Puga M, Albornoz J, Faller E. Surgical strategy in endometriosis. Best Pract Res Clin Obstet Gynaecol. 2013;27(3):381–92.
36. Koninckx PR, Gomel V. Introduction: quality of pelvic surgery and postoperative adhesions. Fertil Steril. 2016;106(5):991–3.
37. Koninckx PR, Donnez J, Brosens I. Microscopic endometriosis: impact on our understanding of the disease and its surgery. Fertil Steril. 2016;105(2):305–6.
38. Anaf V, Nakadi El I, De Moor V, Chapron C, Pistofidis G, Nöel JC. Increased nerve density in deep infiltrating endometriotic nodules. Gynecol Obstet Investig. 2011;71(2):112–7.
39. Arnold J, de Arellano MLB, Rüster C, Vercellino GF, Chiantera V, Schneider A, et al. Imbalance between sympathetic and sensory innervation in peritoneal endometriosis. Brain Behav Immun. 2012;26(1):132–41.
40. Hart RJ HMMPBW. Excisional surgery versus ablative surgery for ovarian endometriomata (Review). 2013 Jan 1;:1–33.
41. Mei Zhang X, Feng Huang X, Xu H, Quinn M. Endometriosis: a consequence of varying injuries to pelvic autonomic nerves. Fertil Steril. American Society for Reproductive Medicine. 2012;98(6):e29.
42. CHAPRON C, Bourret A, CHOPIN N, Dousset B, Leconte M, Amsellem-Ouazana D, et al. Surgery for bladder endometriosis: long-term results and concomitant management of associated posterior deep lesions. Hum Reprod. 2010;25(4):884–9.
43. Anaf V, Nakadi El I, Simon P, Van de Stadt J, Fayt I, Simonart T, et al. Preferential infiltration of large bowel endometriosis along the nerves of the colon. Hum Reprod. 2004;19(4):996–1002.
44. Donnez J. Endometriosis: enigmatic in the pathogenesis and controversial in its therapy. Fertil Steril. 2012;98(3):509–10.
45. William Kondo, Reitan Ribeiro, Carlos Trippia, Monica Tessmann Zomer. Laparoscopic treatment of deep infiltrating endometriosis affecting the rectosigmoid colon: nodulectomy or segmental resection? Gynecol Obstet. 2013;03(01).
46. Afors K, Murtada R, Centini G, Fernandes RP, Meza C, Castellano J, et al. Employing laparoscopic surgery for endometriosis. Womens Health. 2014 Jul;10(4):431–43.
47. Afors K, Centini G, Fernandes RP, Murtada R, Zupi E, Akladios C, et al. Segmental and discoid resection are preferential to bowel shaving for medium-term symptomatic relief in patients with bowel endometriosis. J Minim Invasive Gynecol. 2016;23(7):1123–9.

48. Cherif Akladios MP, Emilie Faller MD, Karolina Afors MD, Marco Puga MD, Jaime Albornoz MD, Christina Redondo MD, et al. Totally laparoscopic intracorporeal anastomosis with Natural Orifice Specimen Extraction (NOSE) techniques, particularly suitable for bowel endometriosis. J Minim Invasive Gynecol. 2014;21(6):1–24.
49. Messori P, Faller E, Albornoz J, Leroy J, Wattiez A. Laparoscopic Sigmoidectomy for Endometriosis With Transanal Specimen Extraction. J Minim Invasive Gynecol. 2013;20(4):412.
50. Costantino FA, Diana M, Wall J, Leroy J, Mutter D, Marescaux J. Prospective evaluation of peritoneal fluid contamination following transabdominal vs. transanal specimen extraction in laparoscopic left-sided colorectal resections. Surg Endosc. 2011;26(6):1495–500.
51. Antonelli A. Urinary tract endometriosis. Urologia. 2012;79(3):167–70.
52. Kovoor E, Nassif J, Miranda-Mendoza I, Wattiez A. Endometriosis of bladder: outcomes after laparoscopic surgery. J Minim Invasive Gynecol. 2010;17(5):600–4.
53. Alves J, Puga M, Fernandes RP, Pinton A, Miranda I, Kovoor E, et al. Laparoscopic management of ureteral endometriosis and hydronephrosis associated with endometriosis. J Minim Invasive Gynecol. 2017;24(3):466–72.
54. Bertrand MM, Alsaid B, Droupy S, Ripoche J, Benoit G, Adalian P, et al. Anatomical basis of the coordination between smooth and striated urethral and anal sphincters: loops of regulation between inferior hypogastric plexus and pudendal nerve. Immunohistological study with 3D reconstruction. Surg Radiol Anat. Springer Paris; 2016:1–10.
55. Ceccaroni M, Clarizia R, Alboni C, Ruffo G, Bruni F, Roviglione G, et al. Laparoscopic nerve-sparing transperitoneal approach for endometriosis infiltrating the pelvic wall and somatic nerves: anatomical considerations and surgical technique. Surg Radiol Anat. 2010;32(6):601–4.
56. Pandis GK, Saridogan E, Windsor ACJ, Gulumser C, Cohen CRG, Cutner AS. Short-term outcome of fertility-sparing laparoscopic excision of deeply infiltrating pelvic endometriosis performed in a tertiary referral center. Fertil Steril. 2010;93(1):39–45.
57. Ruffo G, Sartori A, Crippa S, Partelli S, Barugola G, Manzoni A, et al. Laparoscopic rectal resection for severe endometriosis of the mid and low rectum: technique and operative results. Surg Endosc. 2012;26(4):1035–40.
58. Kondo W, Bourdel N, Tamburro S, Cavoli D, Jardon K, Rabischong B, et al. Complications after surgery for deeply infiltrating pelvic endometriosis. BJOG Int J Obstet Gynaecol. 2011;118(3):292–8.
59. Donnez J, Squifflet J. Complications, pregnancy and recurrence in a prospective series of 500 patients operated on by the shaving technique for deep rectovaginal endometriotic nodules. Hum Reprod. 2010;25(8):1949–58.