Thieme

Surgical Treatment of Deep Endometriosis

Operative Therapie der tief infiltrierenden Endometriose

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ABSTRACT

In deep endometriosis (DE), clusters of endometrium-like cells penetrate more than 5 mm below the peritoneum: The affected organs and tissue structures can eventuate in an alteration of the anatomy with eliminated organ boundaries, which in some cases can pose a real surgical challenge, even for experienced surgeons. A comprehensive description of the different manifestations of the disease can be found in the #Enzian classification. Since the operation is usually the foundation for the successful treatment of DE, what is important are conclusive indications, appropriate preoperative preparation and, above all, appropriate experience on the part of the surgical team. This article aims to provide a review of the surgical options that are currently available.

ZUSAMMENFASSUNG

Bei der tief infiltrierenden Endometriose (TIE) dringen endometriumartige Zellverbände mehr als 5 mm subperitoneal ein: In den betroffenen Organen und Gewebestrukturen kann es dabei zu einer Alteration der Anatomie mit aufgehobenen Organgrenzen kommen, was die operative Therapie im Einzelfall selbst für den Geübten zur Herausforderung werden lässt. Für eine umfassende Beschreibung der unterschiedlichen Manifestationen der Erkrankung liegt aktuell die #Enzian-Klassifikation vor. Da die Operation meistens die Grundlage einer erfolgreichen Behandlung der TIE ist, sind eine überzeugende Indikation, eine angemessene präoperative Vorbereitung, vor allem aber eine entsprechende Erfahrung des operativen Teams entscheidend für den Erfolg. In diesem Artikel soll eine Übersicht über die derzeitigen operativen Möglichkeiten gegeben werden.

Definitions and Symptoms

Endometriosis, which is the formation of clusters of endometrium-like cells outside the uterine cavity, is currently subdivided internationally into three types: peritoneal endometriosis, ovarian endometriosis (endometrioma), and deep endometriosis (DE) [1, 2, 3]. The latter refers to clusters of endometrium-like cells penetrating more than 5 mm below the peritoneum [2, 4]. If the vagina, rectovaginal septum, bladder, bowel, ureter, diaphragm, or scars are affected, these manifestations are considered by definition to be DE. It is estimated that deep endometriosis occurs with a prevalence of 1–2% in the general population, but there are only sparse data available on this [5]. The symptomatology is as individual as the localization and the severity in the patient are. The primary symptoms of endometriosis, dysmenorrhea and chronic abdominal complaints, also occur in the deep infiltrating type. Painful intercourse is common in patients with vaginal or rectovaginal endometriosis, dysuria may be indicative of bladder endometriosis, and dyschezia can be a symptom of bowel endometriosis. However, this is by no means standard: the correlation between the symptoms and the anatomical characteristics of the disease is low [6]. Individual patients with an extensive case of endometriosis show comparatively few symptoms and vice versa. Vegetative symptomatology with nausea, vomiting, or cyclic diarrhea is often observed [7]. Despite the increased attention that the disease has received in recent years, it takes an average of 8–12 years for a diagnosis to be made in Germany [8, 9]. One of the consequences of long-standing endometriosis is chronic pain syndrome, which is often no longer cyclical as the disease progresses; this can, in turn, lead to depressive disorders. Anatomical changes and pro-inflammatory factors can result in infertility and early abortion [7]. It is also known that patients with DE more frequently suffer from complications during pregnancy [10]. It is rare for a malignant tumor to develop on the basis of endometriosis (endometriosis-associated malignancy, EAM): In the majority of cases, these are endometrioid and clear cell ovarian carcinomas, but when it comes to DE, these can also be malignant parametrial and rectal tumors [11, 12].

Classification

The staging of the American Society for Reproductive Medicine (rASRM score) that was introduced decades ago is still a common classification tool used today [13]. The extent of the endometriosis and the presence of adhesions and endometriomas are taken into account and divided into stages I to IV using a point system. The rASRM score focuses on the organs that are important in terms of reproductive medicine, specifically the uterus, ovary, and the surrounding area, yet endometriosis affecting other organs is neglected. Thus, the extent of the disease is not fully recorded; the system hardly correlates with the symptoms of affected patients. Furthermore, it is an inadequate tool for planning surgery, as surgeons are not given any indication of the expected degree of difficulty of the procedure [2].

For that reason, the Stiftung Endometriose-Forschung (SEF) (Endometriosis Research Foundation) inaugurated another classification system in 2003 specifically for deep infiltrating endometriosis [14]. The Enzian classification distinguishes between rectovaginal endometriosis (compartment A), endometriosis of the pelvic wall, the sacrouterine ligaments, and around the ureter (= extrinsic ureteral endometriosis; compartment B), as well as endometriosis of the rectum (compartment C). Endometriosis growths in other locations are preceded by the abbreviation “F”, followed by the letters:

- A for adenomyosis,
- B for bladder,
- I for intestine,
- U for ureter, intrinsic,
- O for other (diaphragm, lung, nerves).

Since combining both classifications – rASRM and Enzian – is cumbersome in everyday clinical practice, and is therefore often not done, the SEF has developed a completion of the Enzian classification, #Enzian, which now also includes endometriosis in the peritoneum (“P”), the ovaries (“O”), the tubes (“T”), as well as secondary adhesions, making it possible to describe the endometriosis topographically in its entirety, as well as its extent and any other organs affected [15, 16]. The initial data collected have shown a correlation between #Enzian and the patient’s symptoms as well as the extent of disease. Further studies on this issue are being carried out [17, 18].

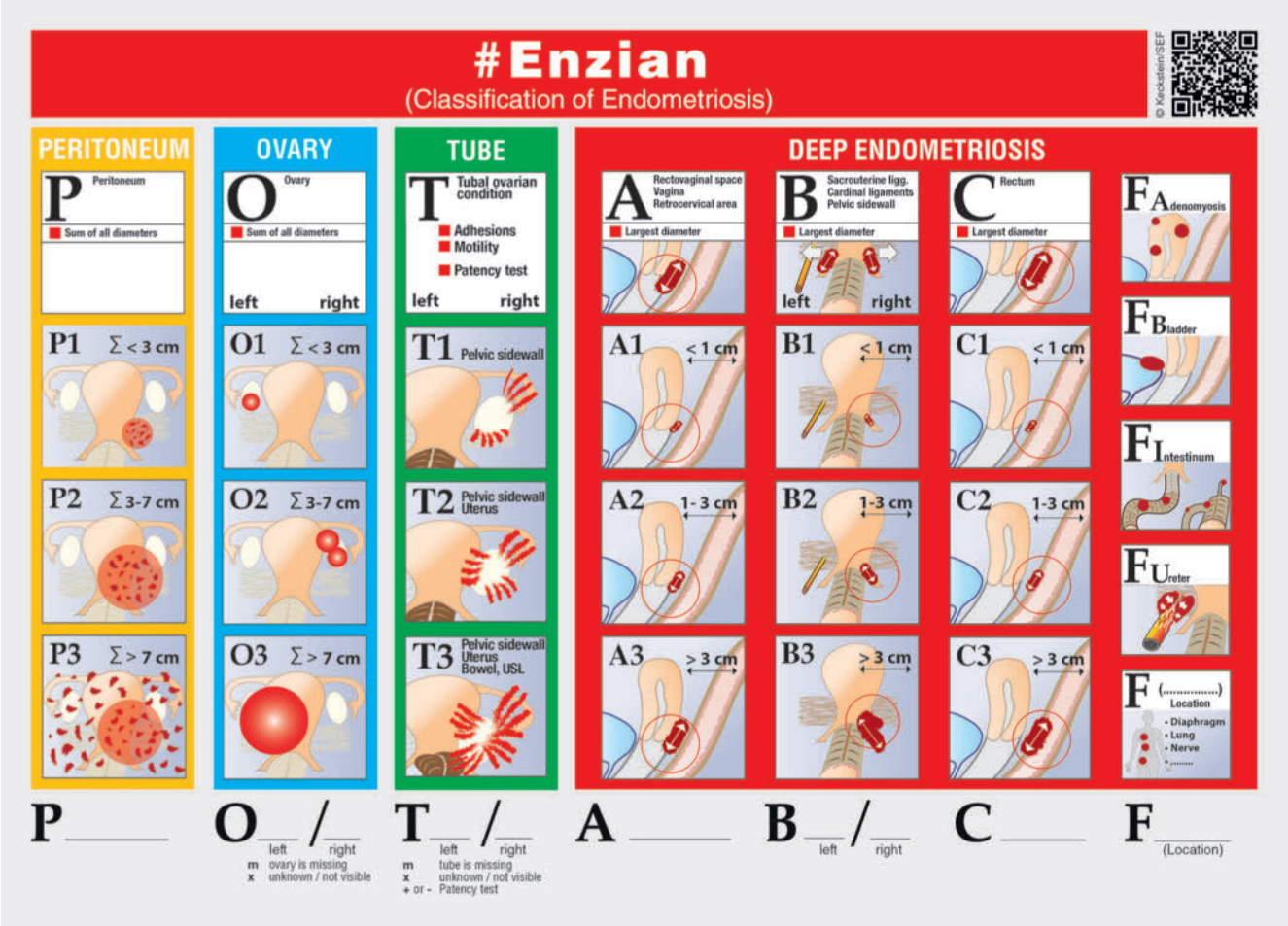
The severity of the superficial peritoneal (< 5 mm depth of invasion) and ovarian endometriosis is described as follows:

- 1: Sum of all lesions < 3 cm,
- 2: Sum of all lesions 3–7 cm,
- 3: Sum of all lesions > 7 cm.

“T” refers to tubo-ovarian adhesions or the mobility of the adnexa:

- 1: Adhesions between the tubes and the pelvic wall or tubo-ovarian adhesions,
- 2: T1 plus adhesions to the uterus or isolated adhesions to uterus,
- 3: T2 plus adhesions to the pelvic wall or bowel, or isolated adhesions to the pelvic wall or bowel.
- If tested, the patency of the tubes is indicated with a + or – symbol.

With the exception of peritoneal endometriosis, which is not adequately shown in imaging and can thus only be classified surgically, the #Enzian classification is also suitable for the preoperative diagnosis of endometriosis. It can be classified preoperatively, both with sonography (identified with the suffix “u”) and MRI (identified with the suffix “m”), as well as intra- and postoperatively (then based on the pathological examination of the surgical preparations; identified with the suffix “s”). The preoperative assessment of the compartments (A/B/C/F) in DE by vaginal sonography (#Enzian “u”) corresponds to a high degree with the intraoperative assessment of the severity of the disease (#Enzian “s”) [18, 19]. Similarly sound results were also achieved when using the #Enzian classification in the context of MRI diagnostics [20]. As a common language for non-invasive and invasive diagnostics, #Enzian is intended to form the foundation for improved clinical and scientific work relating to patients with endometriosis [21, 22, 23, 24, 25] (▶ **Fig. 1**).



▶ **Fig. 1** #Enzian – classification. Source: Keckstein J, Saridogan E, Ulrich UA et al. The #Enzian classification: A comprehensive non-invasive and surgical description system for endometriosis. Acta Obstet Gynecol Scand 2021; 100: 1165–1175.

Diagnostics

The basis for diagnosis, in addition to the often essential anamnestic recording of symptomatology, is a clinical gynecological examination. During speculum insertion, a deep infiltrating growth can be seen in the vagina, especially when looking into the posterior fornix. Deep infiltrating lesions of the rectovaginal septum, pouch of Douglas, and lower rectum can often be palpated during digital vaginal and rectal examination [2]. The examination should be repeated immediately before the operation under anesthesia: the relaxed state often makes the findings even easier to feel. Endometriomas and deep infiltrating growths in the bladder, the rectovaginal septum, and the deep rectum can now be visualized in detail using vaginal sonography [26]. The "sliding sign" allows conclusions to be drawn about adhesions, making it suitable to detect obliteration of the pouch of Douglas [27].

If rectal endometriosis is suspected, rectal endosonography is a helpful alternative to determine the size, position (from the anus), and infiltration depth of the growth. A colonoscopy is useful to determine other diseases of the bowel preoperatively with a differential diagnosis. A colonoscopy is mandatory in the event of rectal bleeding and is required by many visceral surgeons for planned bowel resection [2].

Magnetic resonance imaging often provides an excellent depiction of the situation, but is rarely required for clinical routine. However, it can show specific findings such as bowel endometriosis higher up, which is otherwise usually only diagnosed during surgery [22].

Vaginal ultrasound is currently regarded as the standard tool in the preoperative diagnosis of ovarian endometriosis, DE, and adenomyosis [28]. The ESHRE (European Society of Human Reproduction and Embryology) has been prompted to no longer recommend laparoscopy with histological confirmation as a general measure for diagnosing endometriosis, especially due to the good correlation between the preoperative sonographic assessment and the intraoperative findings; based on this, clinical vaginal sonographic examination is sufficient if the symptomatology meets the criteria [19, 29]. In contrast, the authors of the endometriosis guidelines of the German-speaking countries have retained laparoscopy as the diagnostic standard [30]. If laparoscopy is not performed, it is essential for experts to carry out non-invasive diagnostics with systematic evaluation and description (classification) of the findings [28, 31, 32].

General Information on Surgical Therapy

The decision to operate depends primarily on the clinical issues caused by the disease and on the subjective psychological strain incurred. Asymptomatic patients do not require treatment. If the patient has pain, no desire to have children and no organ destruction, they should first be treated with medication; however, in a study on this constellation, 80% of patients reported side effects [33]. Surgery is only considered the measure of choice if appropriate treatment with medication fails, and is still indicated in the event of suspected organ infiltration with loss of anatomical integrity and/or function, or involuntary childlessness, especially in the case of symptomatic endometriosis; in the latter situation, a specialized center for reproductive medicine should be consulted early on [30, 33]. Doctors must inform the patient extensively about the operation and its potential complications, as well as treatment alternatives, so that the patient can make a conscious and sound decision [34]. Ultimately, the question of whether surgery should be performed can only be answered individually: If doctor and patient come to the conclusion together that the potential complications or consequences of the operation (including a protective, temporary stoma) are perhaps not as serious as the current situation, the indication is correct. A patient suffering severely from dyschezia and painful intercourse caused by DE, and for whom medication did not help, certainly fulfills the requirements for surgery.

Having said that, there is a dilemma when it comes to the scope of the resection: On the one hand, the treatment of all endometriosis growths eventuates in a significant reduction in symptoms and should therefore be the goal of the surgery [2, 5, 34]. On the other hand, anatomical changes due to the invasive progression of the disease, extensive adhesions, and the accompanying inflammatory reaction complicate surgical intervention – even for experienced surgeons. If the rectum or rectovaginal septum are affected, this can lead to complications such as anastomotic failure or rectovaginal fistula formations. An injury to the hypogastric plexus or the splanchnic nerves in the area of the sacrouterine ligaments during parametrial preparation may lead to disorders affecting the emptying of the bladder and bowel, as well as reduced sensitivity in the vaginal area, which is why complete rehabilitation on both sides is avoided in favor of vegetative innervation; in any case, the vegetative nerve plexuses should be precisely depicted and protected [31, 35].

In order to avoid the occurrence of these complications, it is important to prepare well for the operation: In addition to a strict indication, an interdisciplinary team of gynecologists and, depending on the affected organs, visceral surgeons, urologists, and thoracic surgeons should be involved [34]. The operation must be individually adapted to the severity of the findings and the corresponding symptomatology, and treatment at a properly equipped center is recommended.

Preoperative bowel preparation is carried out in many centers – without there being reliable data on this – in order to reduce contamination with intestinal germs in case the intestinal lumen opens, and to create more intra-abdominal space through an empty bowel [2, 36]. There is, nevertheless, insufficient evidence that this reduces the complication rates in endometriosis surgery [37]. Temporary ovariopexy is a simple and uncomplicated technique to improve access to deep infiltrating findings in the pouch of Douglas [38]. Tools, such as uterine mobilizers or rectal probes, can also simplify the work [2].

Vagina, Rectovaginal Septum, (#Enzian A), and Rectum (#Enzian C)

Dysmenorrhea, painful intercourse, and dyschezia are the typical symptoms of deep infiltrating endometriosis of the vagina and rectovaginal septum, which, due to continuous growth, often occur in combination with rectal endometriosis, which is why these three manifestations are discussed together here [30]. Rectal, cycle-synchronous blood loss (hematochezia) would be typical of rectal endometriosis, but does not occur in all patients affected. In all patients with rectal bleeding, it is necessary to perform a preoperative colorectoscopy for diagnostic differentiation from other, primary bowel diseases [30].

The aim of the operation is the complete resection of the affected area, as this improves the patient's quality of life [39].

The following are techniques to resect rectal endometriosis: rectal shaving, full thickness wall excision (disc resection), or segmental resection.

- Rectal shaving: Superficial resection of the endometriosis from the intestinal wall; the lumen is not opened (although the literature usually does not define whether involvement of the muscular intestinal wall is to be taken into account).
- Disc resection: Intestinal wall resection is performed, which e.g., can be done anally with a circular stapler as a semi-circular resection.
- Segmental resection: The relevant rectum segment is resected by means of GIA and the corresponding ends are usually anastomosed transanally with a stapler. In the case of very deep anastomoses (5 cm and less from the anus), a temporary, protective ileostomy is created in individual cases – especially in some centers.

Since complications such as anastomotic failure, rectovaginal fistulas, innervation disorders of the bladder, and postoperative bleeding occur more frequently after segmental resections, the trend in recent years has been towards the less invasive shaving technique [33, 40]. Some believe that not only superficial, but also most larger and deeper infiltrating findings can be resected with this method, so that segmental resection is reserved for very extreme cases with stenosis (> 80% of the lumen restricted) or growths on the posterior rectal wall, which, however, are extremely rare [5, 33, 41]. However, there is a risk that the growth is not removed completely during shaving and that symptoms may still persist after surgery [42]. Contrary to previous assumptions, the methods are equivalent in terms of the probability of recurrence [41]. Reviews, retrospective studies, and case control studies demonstrate that avoiding a radical approach has better results in terms of operation-related morbidity and the complication rate [43, 44]; however, in the only randomized study on this topic, there was – contrary to expectations – no significant difference [45]. In that sense, the decision must be made together with the patient and

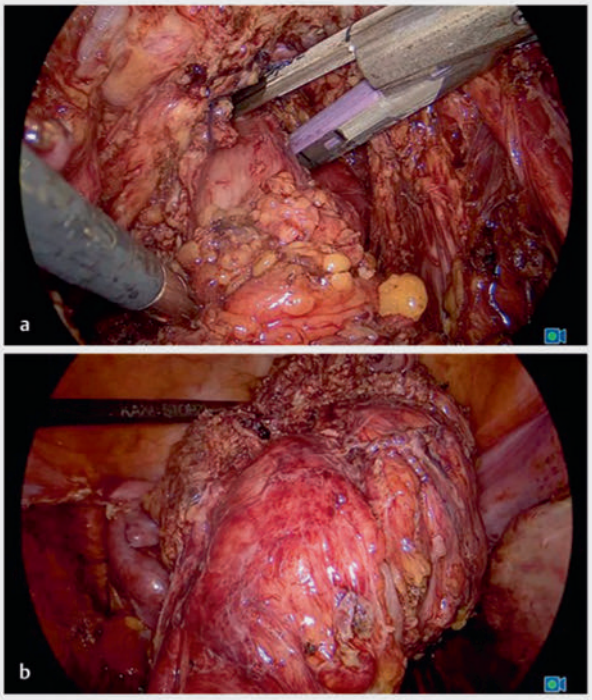
with clinical judgment. Avoiding a radical approach when it comes to DE, especially if the sacrouterine ligaments and the vagina are affected, is the best way to minimize the surgical risks. If the vagina is opened, it can be closed vaginally or abdominally, depending on the type of operation. After extensive endometriosis resection in the posterior compartment, especially with partial colpotomy, a cesarean section should be discussed as the type of delivery if the patient falls pregnant [30]. The postoperative risk of developing a fistula is greater if the vagina is opened with a deep rectal suture at the same time (▶ **Fig. 2**).

Bowel: Sigmoid Colon, Ileocecal Region, Appendix, Small Intestine (#Enzian FI)

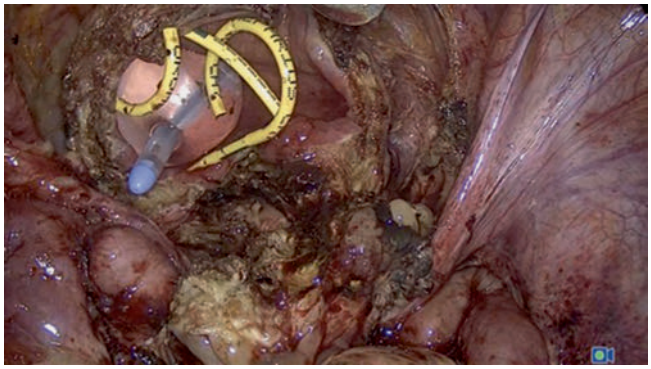
Endometriosis lesions in higher parts of the intestine can become noticeable through symptoms such as dyschezia, tenesmus, obstipation, and diarrhea – also alternating – but are often an incidental finding during surgery as they go unnoticed in gynecological examinations [30]. The vermiform appendix is most often affected, and the sigmoid and cecum are also affected relatively often. A laparoscopic appendectomy is performed to treat the former. Bowel endometriosis in other localizations can be operated on by means of ablation (shaving) if the growth is superficial. In the case of larger or stenosing findings, the affected intestinal section is usually mobilized and moved in front of the abdominal wall by performing a mini-laparotomy, where it is worked on by hand in the traditional way. The disease rarely leads to intestinal obstruction, which can be cause for emergency surgery [46, 47]. This complication can be triggered by hyperstimulation during assisted reproduction (ART) [48].

Bladder (#Enzian FB)

Dysuria, pollakisuria with an imperative urge to urinate, pain in the area of the symphysis, and (cycle-synchronous) hematuria can be symptoms of deep bladder endometriosis, which affects around 1–2 % of patients suffering from endometriosis [30, 49]. Endometriosis is usually found on the posterior wall of the bladder and the fundus, where it presumably originated as adenomyosis growths of the anterior wall of the uterus [2]. The bladder wall can usually be assessed well with sonography of the half-filled bladder [28]. Prior to surgery, a cystoscopy is also useful, since the position of the endometriosis growth, especially in relation to the ureteral ostia, can be specified and, under certain circumstances, ureter splints can be placed preoperatively [50]. As is the case with growths in other localizations, the aim of the operation is complete resection and restoration of organ integrity. Resection – up to and including partial cystectomy – is the gold standard, as it has lower recurrence rates compared to transurethral resection [50, 51]. A continuous detrusor suture is usually placed extramucosally using monofilament suture [30]. Complications, which fortunately occur much less frequently than with rectal surgery, can be secondary bleeding with bladder tamponade, suture insufficiency, reduced bladder capacity, ureteral obstruction, or fistula formation, so that if other, deep endometriosis growths (e.g., rectovaginal, rectum) are present at the same time, a two-stage surgical procedure is sensible and recommended. Overall, the surgical treatment of bladder endometriosis has good therapy results and is marked with pleasantly few complications [51] (▶ **Fig. 3**).



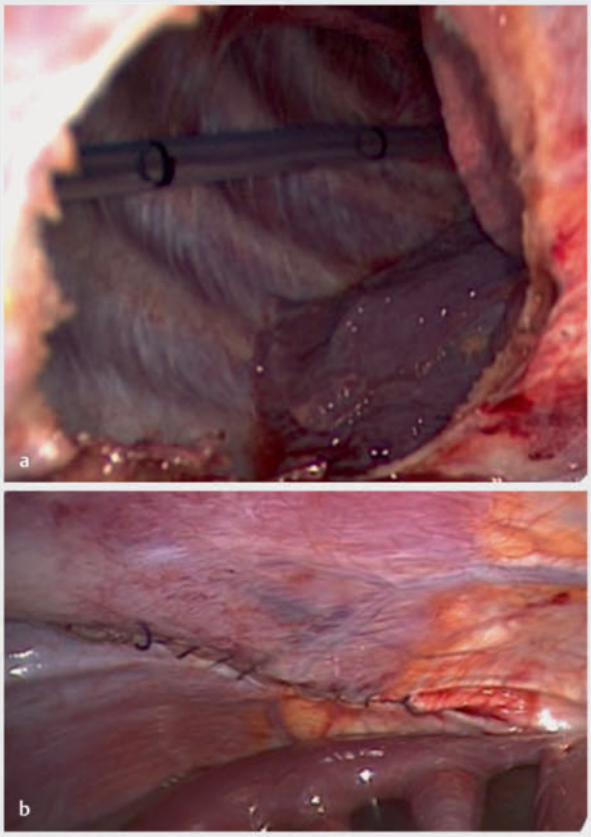
▶ **Fig. 2** **a** #Enzian C3 – Endometriosis: resection of the rectum with the linear stapler. **b** Same finding after resection; affected area totaling 12 cm (Martin Luther Hospital Berlin, Clinic for Gynecology and Obstetrics).



▶ **Fig. 3** Extensive bladder endometriosis after resection: In the foreground, the resected tissue measuring a good 5 cm; view of the urinary bladder with catheter ball and double-J stents on both sides (Martin Luther Hospital Berlin, Clinic for Gynecology and Obstetrics).

Parametrium (#Enzian B) and Ureter (#Enzian FU)

Endometriosis of the pelvic wall, or the parametrium, manifests itself primarily in pain and painful intercourse; if the growth is localized in specific areas (S2 root, obturator nerve, sciatic nerve), the



▶ **Fig. 4** **a** View of the right side of the chest (with collapsed lung and drain) after resection of extensive, transmural diaphragmatic endometriosis. **b** Status post laparoscopic suturing of the diaphragmatic defect; the liver is held caudally and dorsally (Martin Luther Hospital Berlin, Clinic for Gynecology and Obstetrics).

pain can radiate to the respective leg or back. If the ureter is compressed from the outside by deep endometriosis, this is referred to as an extrinsic ureteral endometriosis; if the ureter wall itself is infiltrated by the endometriosis, this is referred to as intrinsic ureteral endometriosis. In most cases, a more distal section of the ureter is affected – and in the majority of cases, the left side [52]. Ureteral endometriosis is inevitably accompanied by endometriosis in the pelvic wall or the parametrium, often also by deep infiltrating growths in other locations, so that the typical endometriosis symptoms can occur in addition to flank pain. However, generally, the flanks do not show symptoms, which can lead to "silent urinary retention" with loss of renal function [52, 53]. Therefore, all patients who suffer from deep endometriosis should be offered a renal ultrasound every six months to rule out urinary obstruction, which is an absolute indication for treatment [30]. In the case of hydronephrosis, a urological diagnostic confirmation of renal function should be carried out preoperatively (retention parameters, renal scintigraphy, cysto-/ureteroscopy, MRI urography, excretory urography) [2].

Surgical treatment (prior to ureter splints), which aims to completely eliminate the ureteral obstruction and thus preserve renal function, includes ureterolysis, if necessary partial ureteral resection with end-to-end anastomosis or, if distal, ureteral reimplantation [54]. In a number of cases, extricating the ureter from its lining involves dissection and resection of the pelvic wall. Also in the case of intrinsic ureteral endometriosis, maximum decompression is worthwhile in most cases, initially with preservation of the ureter, since – with the splint in place – it can heal well; reflex resection of the affected area with ureteroneocystostomy (psoas hitch, Boari) is not recommended. Therapy should take place in close cooperation with colleagues from the urological department [51].

Diaphragm, Pleura, Lung Parenchyma (#Enzian F)

DE in these locations is collectively referred to as "thoracic endometriosis syndrome" (TES), with diaphragmatic endometriosis accounting for 89 % of these cases. Typical symptoms are shortness of breath, right-sided, cycle-dependent pain in the chest, shoulder, and arm, so-called catamenial pneumothorax, which usually occurs on the right side, or hemoptysis. Data suggest that 55–100 % of patients with diaphragmatic endometriosis also have pelvic endometriosis [55, 56].

The medical history, supplemented by MRI, laparoscopy, and, if necessary, thoracoscopy, is the diagnostic foundation. The guidelines for the diagnosis and treatment of endometriosis in German-speaking countries recommend an initial medical treatment attempt for thoracic endometriosis, and surgery only if this attempt is unsuccessful [30]. Superficial findings can be removed by means of ablation or resection, deeper growths infiltrating the diaphragm or pleura should be completely resected. Most centers suture laparoscopically with or without the postoperative insertion of an appropriate chest drain. If large-scale diaphragmatic defects are found – especially if located dorsally to the liver – the thoracoscopic suture as part of a double-cavity procedure together with a thoracic surgical team can, in the authors' experience, be significantly easier and faster (combined laparoscopic and thoracoscopic; video-assisted thoracoscopic surgery, VATS). Potential complications include a diaphragmatic hernia or injury to the phrenic nerve with paralysis of the diaphragm [55]. Hormonal suppression therapy is recommended after surgery for relapse prophylaxis [29] (▶ **Fig. 4**).

Scar Endometriosis (#Enzian F)

Scar endometriosis typically occurs in the region of caesarean section scars, trocar puncture sites, perineal tear and episiotomy scars, and causes cyclical pain in the corresponding area. The growth can often be easily palpated and visualized by means of sonography. In individual cases, an MRI examination can be helpful [30].

A recent study in which Buscemi et al. managed to demonstrate that all of the 46 examined patients with scar endometriosis had a history of a cesarean section corroborates the theory of origin of the iatrogenic spreading of cells [57].

The treatment of choice is complete resection, which can be performed using palpation findings or wire marking. The latter can be helpful as the growth may be difficult to locate once the scar has been opened. Large fascial defects are often closed using mesh [2]. Laparoscopy in the same procedure is recommended to exclude or resect intra-abdominal growths that are present at the same time. This also applies to umbilical endometriosis, which is not necessarily treated surgically. For aesthetically pleasing reconstruction after resection, a plastic surgeon may need to be consulted [29].

Concluding Observations and Outlook

In recent years, surgical therapy of DE has been characterized by an increasingly individual approach. Depending on the symptoms, the involved organ(s), and potential desire to have children, the pros and cons of hormonal and surgical therapy must be discussed with each patient in order to be able to make a sound decision together. The #Enzian classification is now available for a comprehensive, exact description of the manifestations. All the authors agree that preoperative vaginal sonographic diagnostics have progressed to such an extent that diagnostic laparoscopy is no longer required to confirm the diagnosis. Patients benefit from treatment in an appropriate endometriosis center with an experienced interdisciplinary team, which will hopefully further reduce the complication rates in the often complex operations. A certain reduction in a radical surgical approach (e.g., less deep segmental resections in rectal endometriosis) seems to be observed, but precise data are not available on this. In order to achieve a good postoperative quality of life, physicians should ensure a holistic treatment approach (multimodal analgesia, psychosomatic (medicine, symptoms, etc.)/psychotherapy, physiotherapy, complementary treatment options). It is also our task as surgeons to better integrate these efforts into everyday clinical practice and to make them accessible to patients.

Conflict of Interest

The authors declare that they have no conflict of interest.

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