Chapter 23
Surgical Management of Endometriosis

Imari Deura and Tasuku Harada

Abstract Endometriosis, a common disease affecting about 10 % of women of reproductive age, causes pelvic pain and infertility. Pelvic endometriosis is histologically categorized into peritoneal superficial endometriosis, ovarian endometrioma, and deep infiltrating endometriosis (DIE). Surgical treatment for endometriosis aims to relieve symptoms and preserve fertility, in most cases by restoring anatomy, by lysing adhesions, and by removing endometriotic lesions. Laparoscopic surgery, which is the standard surgical procedure for endometriosis, reduces pelvic pain and improves fertility by means of excision and ablation of endometriotic lesions. Managing endometriomas in women who wish to conceive is controversial because two main risks may occur after conservative surgery: recurrence of the disease and significant reduction in ovarian reserve. Surgical treatment for endometriosis should be tailored to the individual according to clinical presentation and personal wishes. In this chapter, we describe laparoscopic conservative surgery for pelvic endometriosis, particularly for ovarian endometrioma.

Keywords Cystectomy • Infertility • Laparoscopic surgery • Ovarian endometrioma • Ovarian reserve

23.1 Surgical Approach for Endometriosis

Laparoscopy compared with laparotomy is considered the gold standard surgical treatment for endometriosis, especially when endometriomas are present. The two approaches do not differ in terms of pain relief, fertility outcome, and risk of recurrence [1–4]. One randomized controlled trial (RCT) revealed that laparoscopic

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surgery for endometriomas was associated with less pain after surgery, shorter hospital stay, and faster recovery compared with laparotomy and that the complication rate and operative time were similar in the two approaches [5]. A meta-analysis of 27 RCTs comparing the outcome of laparoscopic surgery and laparotomy for benign gynecologic pathologies also showed that the two approaches exposed patients equally to complications [6]. These results suggest that laparoscopic surgery, minimum invasive technique, is feasible and safe as well as laparotomy and that it should be used as a first-line choice in conservative surgery for endometriosis.

23.2 Surgical Treatment for Endometriosis-Associated Pain

Endometriosis is present in approximately 70 % of patients with pelvic pain [7]. Endometriotic lesions and adhesions are clearly associated with pain symptoms, which include dysmenorrhea, non-menstrual chronic pelvic pain, dyspareunia, and dyschezia. These symptoms significantly affect the quality of life of women of reproductive age. Lesions and adhesions are included in several scoring systems, for example, the commonly used revised American Fertility Society (rAFS) classification, which describes the severity of endometriosis, but not the severity of pain. The relationship between the stage or lesion type of endometriosis and severity of pelvic pain has been studied, but the results are inconsistent [8]. Severe pelvic pain is associated with DIE; however, the depth of endometriosis does not affect the stage of rAFS classification. This may be one reason that this scoring system failed to show severity of pain.

Endometriosis can be treated either medically or surgically. Surgery allows visual diagnosis and is usually used when medical treatment fails or produces unacceptable side effects or when conception is desired. The aim of surgical treatment is to restore anatomy by dividing adhesions and removing visible endometriotic lesions, thus relieving pain. Endometriosis often develops in women of reproductive age; therefore, laparoscopic surgery commonly needs to preserve fertility.

The RCT reported by Sutton et al. showed that laparoscopic laser ablation resulted in statistically significant pain relief at 6 months after surgery in women with minimal to moderate endometriosis compared with diagnostic laparoscopy [9]. A follow-up study of Sutton's RCT demonstrated that pain relief after laparoscopic laser ablation continued at 1 year in 90 % of those who initially responded [10]. Abbott et al. performed a randomized, placebo-controlled trial of patients with minimal to severe endometriosis, comparing laparoscopic excision with placebo, and found that 80 % of the excision group had reduced pain and improved quality of

life by 6 months compared with only 32 % in the placebo group. Surprisingly, diagnostic laparoscopy was associated with a 20 % placebo response rate [11]. A meta-analysis consisting of five RCTs also demonstrated an advantage in using laparoscopic surgery for pelvic pain associated with endometriosis compared with diagnostic laparoscopy alone [12]. The two RCTs reported that 20–38 % of patients had no improvement in symptoms after operative laparoscopy [9, 11], implying that surgical treatment alone for endometriosis-associated pain has limitations.

Which of the laparoscopic surgical modalities is most effective for pain relief in endometriosis is inconclusive. Healey et al. showed no difference in pain relief between laparoscopic ablation and excision at 12 months after surgery for patients with minimal to severe endometriosis [13]. A similar result was reported in another study of minimal to mild endometriosis [14].

Several surgical procedures to interrupt pelvic nerve pathways have been performed to reduce pelvic pain caused by endometriosis, such as uterine nerve ablation, presacral neurectomy, uterosacral ligament resection, and so on. However, there is insufficient evidence of pain relief to recommend their use [15, 16].

23.3 Surgical Treatment for Endometriosis-Associated Infertility

Endometriosis is present in 20–68 % of subfertile women [17]. Severe endometriosis may impair fertility due to anatomical distortion caused by adhesions. However, endometriosis is associated with infertility even in the early stages without adhesions. The exact mechanism by which endometriosis interferes with fertility is not fully understood, and therefore the strategy for treatment is controversial. Medical treatment that suppresses ovarian function has no effect to improve fertility in women with endometriosis and should not be offered to patients wishing to conceive [18]. Adamson et al. demonstrated that surgical treatment was superior to medical treatment regarding the pregnancy rate of infertile women with minimal and mild endometriosis [19]. Whether surgical treatment or artificial reproductive technique should be performed first has been debated.

Endometriosis is treated surgically by lysing adhesions and excising or ablating endometriotic lesions.

A meta-analysis consisting of two RCTs demonstrated that laparoscopic surgery, including excision and ablation with adhesiolysis, improves fertility in patients with minimal and mild endometriosis compared with diagnostic laparoscopy alone [20]. There seems to be a negative correlation between the stage of endometriosis and the spontaneous cumulative pregnancy rate after surgical excision of endometriosis. No evidence recommends choosing laparoscopic surgery first for patients with moderate or severe endometriosis complaining of infertility alone [21].

23.4 Ovarian Endometrioma

23.4.1 Surgery for Endometrioma

Ovarian endometrioma, also known as chocolate cyst, is a form of endometriosis located on the ovaries. Between 17 and 44 % of patients with endometriosis have endometriomas [22–24]. Endometriosis by itself does not always cause endometriosis-related symptoms. No consensus has been reached on the definitive intervention for endometrioma, particularly in infertile women.

Surgical treatment is usually recommended for large symptomatic endometrioma, and the indication for surgery also depends on the risks of rupture, infection, torsion of the ovary, and malignant formation. Laparoscopic surgery is the gold standard for endometrioma [5], but which is the best modality of conservative surgery remains controversial. Drainage of endometriomas alone is not recommended because of the high recurrence rate [25]. Two main modalities are used: ablation of the cyst wall and cyst excision, also called cystectomy. Laparoscopic cystectomy has been considered a first-line choice of surgical treatment. A meta-analysis demonstrated that laparoscopic cystectomy for endometriomas larger than 3 cm in diameter increased spontaneous conception in subfertile women with less recurrence of pain symptoms and fewer endometriomas compared with ablation alone. Ovarian response to gonadotrophin stimulation after surgery was similar between the two modalities despite concerns over the more damaging effect of cystectomy on ovarian reserve [26].

23.4.2 ART and Endometrioma

Endometrioma may interfere with the outcome of artificial reproductive technology (ART). ART cycles of women with endometriomas have several problems, including difficulty monitoring ovarian response by ultrasound, poor ovarian response to controlled ovarian stimulation (COH), and infection after oocyte pick up [27–29]. Gupta et al. showed decreased ovarian response to COH with in vitro fertilization (IVF) cycles of patients with endometriomas compared with controls [30], which implies a decline of ovarian reserve due to endometrioma itself.

Endometriomas larger than 3 cm are generally treated surgically before ART, but surgery may actually decrease the success of ART due to damaged ovarian reserve. Demirol et al. evaluated the outcome of intracytoplasmic sperm injection (ICSI) in patients with prior cystectomy for endometrioma between 3 and 6 cm in diameter compared with ICSI alone. Cystectomy resulted in longer COH, higher FSH requirement, and lower mature oocyte number, but fertilization, pregnancy, and implantation rates did not differ [31]. Two meta-analyses concluded that surgical treatment of endometriomas prior to ART did not improve reproductive outcome [32, 33].

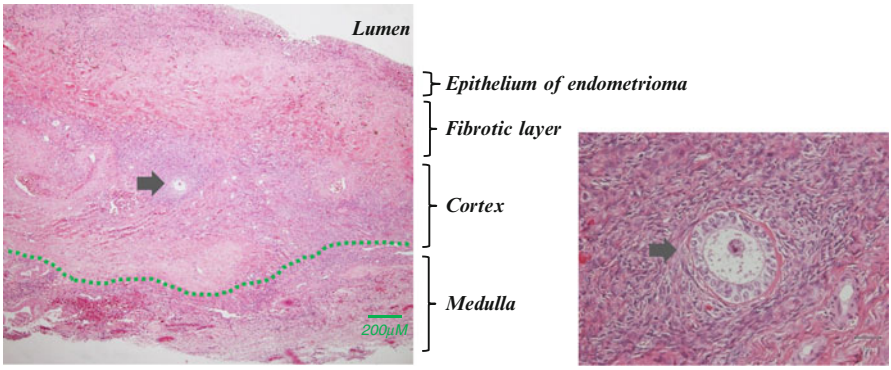

Fig. 23.1 Normal ovarian tissue adjacent to the cyst wall of endometrioma. The tissue specimen of the stripped cyst wall of endometrioma contains normal ovarian tissue. *Arrows* ovarian follicle

23.4.3 Ovarian Reserve and Endometrioma

The pathogenesis of endometrioma is controversial. Endometrioma is generally believed to result initially from a deposit of endometrium that passed through the fallopian tube causing adherence of the ovary to the pelvic peritoneum and progressive vagination of the ovary [34–36]. Considering that endometrioma is a pseudocyst, cyst excision may involve removing some ovarian tissue [37]. One concern over performing cystectomy for endometrioma is that it may damage ovarian reserve when normal ovarian cortex is removed and thermal coagulation is used for hemostasis, resulting in the loss of follicles (Fig. 23.1).

Ovarian reserve is defined as the total ovarian follicle pool including primordial and growing follicles [38]. Serum anti-Mullerian hormone (AMH) is the most useful, reliable, and sensitive marker of ovarian reserve compared with other known serum markers [39]. AMH is stable throughout the menstrual cycle and sensitive to decline in ovarian reserve with aging and is not affected by the use of hormones [40]. Serum AMH correlates to antral follicle count (AFC) measured by ultrasound, which is also a reliable marker of ovarian reserve [41].

A meta-analysis of eight prospective cohort studies to investigate the effect of cystectomy for endometrioma on ovarian reserve as determined by serum AMH level found that serum concentration of AMH significantly decreased after surgery [42]. Multivariate analyses showed that the risk factors associated with reduction of serum AMH after cystectomy were as follows: bilateral endometriomas, presurgical serum AMH level, and the presence of normal ovarian tissue in the enucleated cyst [43–45]. Var et al. compared postsurgical ovarian reserve determined by AFC between laparoscopic cystectomy and ablation for bilateral endometriomas. AFC was significantly decreased in cystectomized ovaries compared with ablated ovaries [46]. One surgical modality used as an alternative to cystectomy, a three-step procedure proposed by Donnez et al., involves drainage of the cyst during

laparoscopy, GnRH agonist treatments, and then laser vaporization of the remains during a second laparoscopy [47]. Ovarian reserve, determined by AMH and AFC, was less diminished after the three-step procedure for endometrioma compared with cystectomy [48, 49]. Donnez et al. also proposed a combined technique consisting of excision of a large part of the endometrioma and laser vaporization of the remaining 10–20 % of the cyst wall close to the hilus. AFC after the combined technique was similar to that of women without endometriosis or contralateral normal ovaries [50]. Use of electrosurgical coagulation to achieve hemostasis after stripping the endometrioma may amplify damage to ovarian reserve. Why ovarian reserve declines after cystectomy is not precisely understood, but it may relate to the methods used for hemostasis, including suturing the ovaries and bipolar coagulation [51, 52]. Details of the studies evaluating ovarian reserve before and after cystectomy are shown in Table 23.1 [53–57].

We know that laparoscopic cystectomy for endometrioma has a negative impact on ovarian reserve, but we should take into account that the presence of endometrioma per se is also associated with a decrease in ovarian reserve [58].

23.4.4 Recurrence of Endometrioma

The recurrence of endometrioma after conservative surgery is a serious problem. Postoperative recurrence rates vary between 6 and 78 % after 2–5 years, depending on the surgical modality and the length of postoperative time [59–66]. Details of the studies evaluating the recurrence rates of endometriomas after surgery are shown in Table 23.2. Long-term follow-up is necessary to assess endometrioma recurrence after surgery. The risk factors for recurrent endometrioma are often varied, and the rAFS staging system is not predictive of recurrence [67, 68].

Cochrane study comparing the recurrence of endometriomas and pain symptoms after surgery showed that cystectomy is more advantageous than ablation [26]. Carmona et al. found an earlier recurrence of endometriomas at 5 years of follow-up after ablation compared with cystectomy [69].

Repeated surgery for recurrent endometriomas is not recommended. The probability of conception after secondary surgery is almost half that after a primary surgery. The repetitive damage to the ovaries should be avoided to preserve the already reduced reproductive potential.

Curing endometriosis by conservative surgery alone is difficult, and studies have shown that postoperative medical treatment can only delay the recurrence of endometrioma [70]. However, a recent report showed that treating with long-term oral contraceptives decreases the recurrence of endometrioma.

The patients should be informed of the risk of postoperative recurrence, and long-term adjuvant treatment to suppress ovulation suggested until pregnancy is desired.

Table 23.1 Ovarian reserve before and after cystectomy

Study	Design	Sample size	Follow-up (month)	Variable	Outcome		*P* value
					Preoperative	Postoperative	
Tsolakidis 2009 [49]	RCT	10	10	AMH	3.9 ± 1.3	2.9 ± 0.6	0.002
Pados 2010 [48]	RCT	10	12	AFC	2.0 ± 1.3	2.4 ± 0.8	NS
Biacchiardi 2011 [53]	Prospective cohort	43	9	AMH	3.0 ± 0.4	1.3 ± 0.3	<0.001
Celik 2012 [45]	Prospective cohort	65	6	AMH	1.8 ± 1.7	0.7 ± 0.8	<0.001
Ercan 2010 [54]	Prospective cohort	64	1	AMH	1.6 ± 1.1	1.4 ± 1.2	NS
Ercan 2011 [55]	Prospective cohort	36	3	AMH	2.0 ± 0.4	1.95 ± 0.6	NS
Kitajima 2011 [44]	Prospective cohort	19	3	AMH	4.3 ± 3.0	3.0 ± 2.5	NA
Hirokawa 2011 [45]	Prospective cohort	38	1	AMH	3.9 ± 2.5	2.1 ± 1.6	<0.001
Hwu 2011 [56]	Prospective cohort	31	3	AMH	3.9 ± 0.4	2.01 ± 0.2	<0.01
Lee 2010 [57]	Prospective cohort	13	3	AMH	4.7 ± 2.5	3.3 ± 2.1	<0.05
Uncu 2013 [58]	Prospective cohort	30	6	AMH	2.8 ± 2.2	1.8 ± 1.3	0.02
Var 2011 [46]	RCT	48	6	AFC	5.6 ± 1.1	3.67 ± 1.3	0.001

Note: Values are mean ± SD. AMH levels are reported in nanograms per milliliter. $P < 0.05$ was statistically significant
RCT randomized controlled trial, *AMH* anti-Mullerian hormone, *AFC* antral follicle counts, *NS* not statistically significant, *NA* not available

Table 23.2 Recurrence rate of endometrioma after cystectomy or ablation

Study	Design	Sample size	Follow-up (year)	Recurrence rate		*P* value
				Cystectomy (%)	Ablation (%)	
Alborzi 2004 [59]	RCT	100	2	17.3	31.3	0.16
Beretta 1998 [60]	RCT	64	2	6.2	18.8	NS
Busacca 1999 [61]	Retrospective follow-up	366	4	11.7		NA
Carmona 2011 [69]	RCT	74	5	22.2	36.8	0.2
Fedele 2006 [62]	Descriptive	305	5	18.9		NA
Hart 2011 [26]	Meta-analysis	164	2	13.1	26.3	<0.05
Hemmings 1998 [63]	Retrospective	103	3	8.0	12.0	NS
Kikuchi 2006 [64]	Retrospective	315	3	27.0		NA
Koga 2006 [65]	Retrospective	224	2	30.4		NA
Saleh 1999 [66]	Retrospective	231	4	25.0	78.0	0.0003

Note: $P < 0.05$ was statistically significant. *RCT* randomized clinical trial, *NS* not statistically significant, *NA* not available

23.5 Laparoscopic Techniques for Endometriosis

Laparoscopic conservative surgery for endometriosis aims to restore anatomy by means of adhesiolysis and by destructing endometriotic lesions. Advanced technical skills and systematic surgical procedures are required to prevent damage to adjacent organs, particularly in cases with an obliterated cul-de-sac.

Peritoneal endometriosis can be destructed by excision or ablation, the latter being commonly used. Symptom relief after surgery does not differ between excision and ablation [71]. Bipolar coagulation and vaporization with CO_2 laser or plasma energy are often used as ablation techniques. Laser vaporization penetrates tissue at a shallow depth, which is useful to avoid deep thermal tissue damage.

Delicate manipulation of forceps is needed to dissect pelvic adhesions. There are two types of adhesions in endometriosis, filmy adhesions and dense adhesions with fibrotic tissue. Filmy adhesions can be dissected bluntly, while dense adhesions require sharp dissection. A contralateral traction should be applied with the proper instruments (e.g., a uterine manipulator). Dissection techniques are used to lyse adhesions surrounding the ovaries, remove the ovarian cysts, and open the obliterated cul-de-sac.

To free adhesions surrounding the ovaries, contralateral traction should be applied (Fig. 23.2a). Fibrotic tissue can be dissected sharply using monopolar diathermy with pure cutting current. Sharp and blunt dissections are repeated alternatively until the whole length of the utero-ovarian ligament is visible. The cyst is almost always ruptured during this procedure.

The procedures for ovarian cystectomy are followed. The content of the cyst is aspirated. The ovarian incision obtained by cyst rupture is enlarged (Fig. 23.2b). The cleavage plane between the cyst wall and the ovarian tissue should be adequately identified (Fig. 23.2c). The cyst wall is bluntly stripped from ovarian tissue

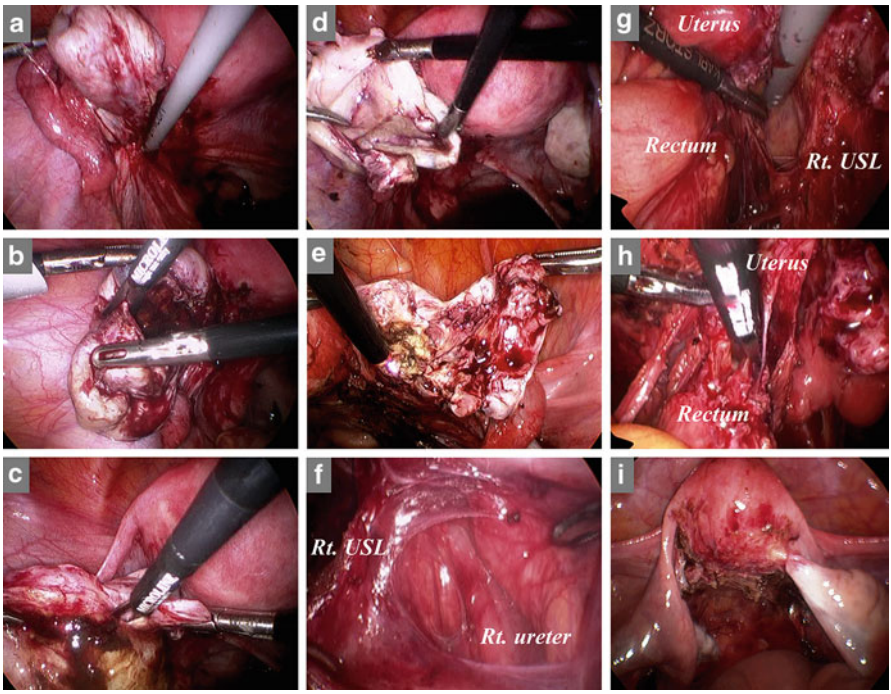

Fig. 23.2 Laparoscopic techniques for endometriosis. (**a**) The adhesion surrounding the left ovary is freed. (**b**) The ovarian incision obtained by cyst rupture is enlarged. (**c**) The cleavage plane between the cyst wall and normal ovarian tissue is adequately identified. (**d**) The cyst wall is bluntly stripped from normal ovarian tissue. (**e**) Laser vaporization is applied to the cyst wall close to the left ovarian hilus. (**f**) The spaces outside the right uterosacral ligament are opened and the right ureter is separated from the right uterosacral ligaments. *Rt. USL* the right uterosacral ligament. (**g**) The space inside the right uterosacral ligament is opened and the rectum is separated from the right uterosacral ligaments. The right uterosacral ligament. (**h**) Sharp dissection using the scissors is applied between the uterus and the rectum. (**i**) The obliterated cul-de-sac is opened

with atraumatic forceps and scissors applying a contralateral traction (Fig. 23.2d). The boundary between the cyst wall and the ovarian tissue should be exposed constantly. After removal of the cyst wall, hemostasis is achieved with the pinpoint bipolar coagulation of bleeding sites on the ovary. The combined technique is sometimes used for patients with bilateral or multiple endometriomas [50] (Fig. 23.2e). The vasopressin injection technique may be useful to decrease bleeding after stripping the endometrioma [72], but an inadequate cleavage plane resulting from hydrodissection may cause the removal of normal ovarian tissue.

The procedures to open an obliterated cul-de-sac are followed. First, the bilateral ureters are identified. The spaces outside the bilateral uterosacral ligament are opened and the ureters are separated from the uterosacral ligaments (Fig. 23.2f). After separation of the ureters, the spaces inside the uterosacral ligaments are opened and the rectum is separated from the uterosacral ligaments (Fig. 23.2g).

The adhesion between the rectum and the uterine cervix can be dissected bluntly with a contralateral traction when the adhesion is not dense. Sharp dissection is needed to dissect dense adhesions with fibrotic tissue. Monopolar diathermy with pure cutting current can dissect dense adhesions surrounding the rectum. Sharp dissection using the scissors should be used to avoid thermal injury of the rectum (Fig. 23.2h). After these procedures to open the obliterated cul-de-sac, it is possible to remove the DIE lesions of the uterosacral ligaments and the rectovaginal septum (Fig. 23.2i).

23.6 Conclusions

Surgical candidates might include the following patients with endometriosis: those with severe pain symptoms, large ovarian endometriomas, and infertility caused by minimal and mild endometriosis.

Surgery for endometriosis has an important role in relieving pain symptoms and improving fertility by lysing adhesions and removing lesions. However, the optimal procedure is as yet undetermined because of several controversial issues: the recurrence of disease and ovarian reserve decline after conservative surgery. Complete cure of endometriosis is not currently possible by surgery alone, particularly the conservative procedure. Surgical treatment of endometriosis should be tailored to the individual according to clinical presentation and personal wishes, and combined treatment with medical treatment or ART after surgery is needed. We cannot deal with all patients with endometriosis in the same way.

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