Single-Port Laparoscopic Adnexal Surgery

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Laparoscopic management of the adnexa in gynecology dates back to the initial descriptions of diagnostic laparoscopy and laparoscopic tubal surgery in the early 1900s. In 1910, a Swedish physician named Jacobeaus was credited with coining the term *laparoscopy* when he performed the first intraperitoneal "scope" using a cystoscope. Despite the discovery of this novel technique to see inside the abdomen with only a small incision, laparoscopy got off to a slow start in the United States. In the late 1940s, TeLinde and colleagues [1] described the use of a rigid scope placed though the vagina for evaluation of the adnexa. TeLinde termed this *culdoscopy* and used it in the work-up of fertility patients, as well as to assess for ectopic pregnancy before laparotomy. The visualization of the pelvic abdominal cavities via a transvaginal approach was one of the foundations for natural orifice surgery [2]. Transabdominal laparoscopic visualization of the peritoneal cavity took a little longer to catch on in the United States. It was not until the late 1960s, when descriptions of laparoscopic tubal cauterization using a single-channel operative laparoscope with a mirrored lens began to surface, that operative laparoscopy gained more interest [3]. Since that time, innovations in technology have greatly improved the optics and the safety of laparoscopic equipment, while technical innovations and forward-thinking surgeons have identified new potential applications for operative laparoscopy. The result has been a recent surge in publications on standard laparoscopic, robotic-assisted laparoscopic, and, more recently, single-port laparoscopic management of benign and malignant adnexal conditions. This chapter focuses on single-port laparoscopic management of the adnexa in gynecologic surgery.

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10.1 Patient Selection and Indications

Indications for single-port laparoscopic adnexal surgery do not differ from indications for standard laparoscopic procedures. The choice of which patients should be offered laparoscopy for the management of pelvic pathology should be based on sound clinical judgment and the skills of the surgeon. A patient with a highly suspicious, malignant-appearing mass on ultrasound and a CA-125 of 300 may not be the best candidate for single-port (or even standard) laparoscopic management. On the other hand, a woman with a mostly simple but enlarging 8-cm ovarian cyst with a thin septation and a normal CA-125 would be a perfect candidate for a trial of single-port laparoscopy.

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Mass size has been used in the past for patient selection for both surgery and laparoscopy. Ghezzi et al. [4] found that women with adnexal masses larger than 10 cm and no evidence of ascites or metastases had an 8.6 % risk of ovarian cancer, a 4.3 % risk of low malignant potential tumors, and a 0.5 % risk of metastatic tumors in the ovary. Thus more than 85 % of tumors larger than 10 cm were benign and could safely be managed by laparoscopy.

10.2 Potential Benefits and Risks

One of the most important benefits of single-port laparoscopy is the slightly larger size of the incision, approximately twice that of a standard 12-mm laparoscopic port but small enough to hide within the umbilicus in most patients. This extra length of the incision allows for more flexibility in surgery, with easier extraction of the mass. Nevertheless, the requirement persists that larger cystic masses must be drained and more solid masses must be morcellated; both of these procedures should be carried out within a laparoscopic specimen retrieval bag (Fig. 10.1). Use of the umbilical incision, which may be enlarged as needed, avoids the need to "stretch" or extend lateral 12-mm port incisions to help with specimen retrieval, which may increase postoperative pain and hernia formation. Smaller ovaries can often be removed intact and sometimes do not require a specimen retrieval bag at all, especially if the single-port device has a transabdominal wall sleeve, such as seen with the Applied Medical Gel Point™ (Rancho Santa Margarita, CA) or Olympus TriPort/Quadport (Center Valley, PA).

That said, several challenges with single-port laparoscopic surgery in gynecology have been well documented (Table 10.1). The most

Table 10.1 Potential benefits and drawbacks of single-port laparoscopy for adnexal masses

Potential benefits
Easier specimen extraction
Easy conversion if cancer
Better cosmesis
Decreased pain
Better exposure for fascial closure
Potential drawbacks
Difficult learning curve
Instrument clashing
Possible increased rupture risk
Increased operative time (initial)

Table 10.2 Potential etiologies of adnexal masses

Benign etiologies
Ovarian cysts
Ovarian torsion
Hemorrhagic cyst
Theca lutein cyst
Benign ovarian neoplasms
Epithelial
Germ cell
Sex-cord/stromal
Infectious/inflammatory
Tubo-ovarian abscess
Appendiceal abscess
Diverticular abscess
Endometrioma
Fallopian tube lesions
Hydrosalpinx
Paratubal cyst
Ectopic pregnancy
Other masses
Peritoneal inclusion cyst
Leiomyomas
Malignant etiologies
Ovarian malignancy
Epithelial carcinoma
Germ cell tumors
Sex cord/stromal tumors
Sarcomas
Fallopian tube carcinoma
Low malignant potential tumors
Metastatic lesions of adnexa
Carcinomas
Gastrointestinal
Breast
Pancreatic
Pseudomyxoma/appendiceal tumors
Sarcomas

common themes listed are instrument collision (both inside and outside of the peritoneal cavity), lack of triangulation of instrumentation, and loss of depth perception when the instruments are in line with the laparoscope. Some of these limitations have been overcome by novel instrumentation including articulating laparoscopes, articulating instruments, and improved camera optics. Nevertheless, even advanced laparoscopic surgeons experience a short learning curve when switching to a single-port laparoscopic approach. This learning curve has been documented by several studies looking at operative time and proficiency in single-port procedures. Fader et al. [5] studied all laparoendoscopic single-site surgeries (LESS) by gynecologic oncologists with advanced laparoscopic skills at three institutions and showed that both port placement and operative times markedly decreased between the first 10 cases and the 11th and 20th cases. Moreover, operative times stabilized after the first 20 cases. Additionally, Lee et al. [6] reviewed a single surgeon's experience over 500 gynecologic cases in Korea and found that the majority of benign gynecologic procedures could be performed by single-port laparoscopy. In this study, there was progression in each quintile of cases from the use of multiple ports to a single port (use of 2 or more ports in 48 % of the first 100 cases versus less than 10 % in the last group of 100 cases), and a continued decline in laparotomy (29 % in the first 100 cases to 4 % for the last 100 cases). The quintiles did not differ with regard to surgical indication, procedure, prior laparotomies, adnexal size, or uterine weight. These findings make an argument for attempting to increase any form of laparoscopic surgery versus laparotomy in gynecologic surgery.

The selection of surgical candidates for single-port laparoscopic surgery for adnexal masses is no different than selection for standard laparoscopy. Etiologies of adnexal masses vary and can sometimes be identified preoperatively (Table 10.2). Ovarian masses can be segregated into high-risk and low-risk based on patient age, family history, symptoms, ultrasound findings, and tumor markers. These criteria can also be used to identify which patients should be referred to a gynecologic oncologist (Table 10.3) [7]. There is no absolute contraindication for the use of single-port laparoscopy compared with standard laparoscopy. However, several studies on single-port adnexal mass management have used various exclusion criteria, including suspicion of malignant tumor, emergent surgery, coexistence of other surgeries [8], tumor larger than 7 cm, age older than 70 years, and previous abdominal surgery for malignancy [9]. We have found that most gynecologic procedures can be adapted to the single-port approach with relatively few true contraindications. Even patients with one or more prior abdominal surgeries may be considered for the single-port laparoscopic approach, given that this is an open laparoscopy placement with a slightly larger incision. We have found that we are able to take down adhesions around the entry site enough that the single-port system can be placed and additional adhesiolysis, ureterolysis, extensive sidewall dissection can be performed laparoscopically (Figs. 10.2, 10.3, and 10.4). Nonetheless, clinical judgment should dictate each individual surgeon's comfort in choosing laparoscopy over laparotomy.

Table 10.3 SGO/ACOG guidelines for referral to a gynecologic oncologist

Postmenopausal	Premenopausal
Elevated CA-125	CA-125 >200 U/mL[a]
Ascites	Ascites
Nodular or fixed pelvic mass	–
Evidence of metastasis	Evidence of metastasis
Family history of one or more first-degree relatives with ovarian or breast cancer	Family history of one or more first-degree relatives with ovarian or breast cancer

Adapted from Im et al. [7]
ACOG American College of Obstetricians and Gynecologists, *SGO* Society of Gynecologic Oncologists
[a]Sensitivity and positive predictive value for referral in premenopausal women was low and can be increased by using a lower cutoff for CA-125

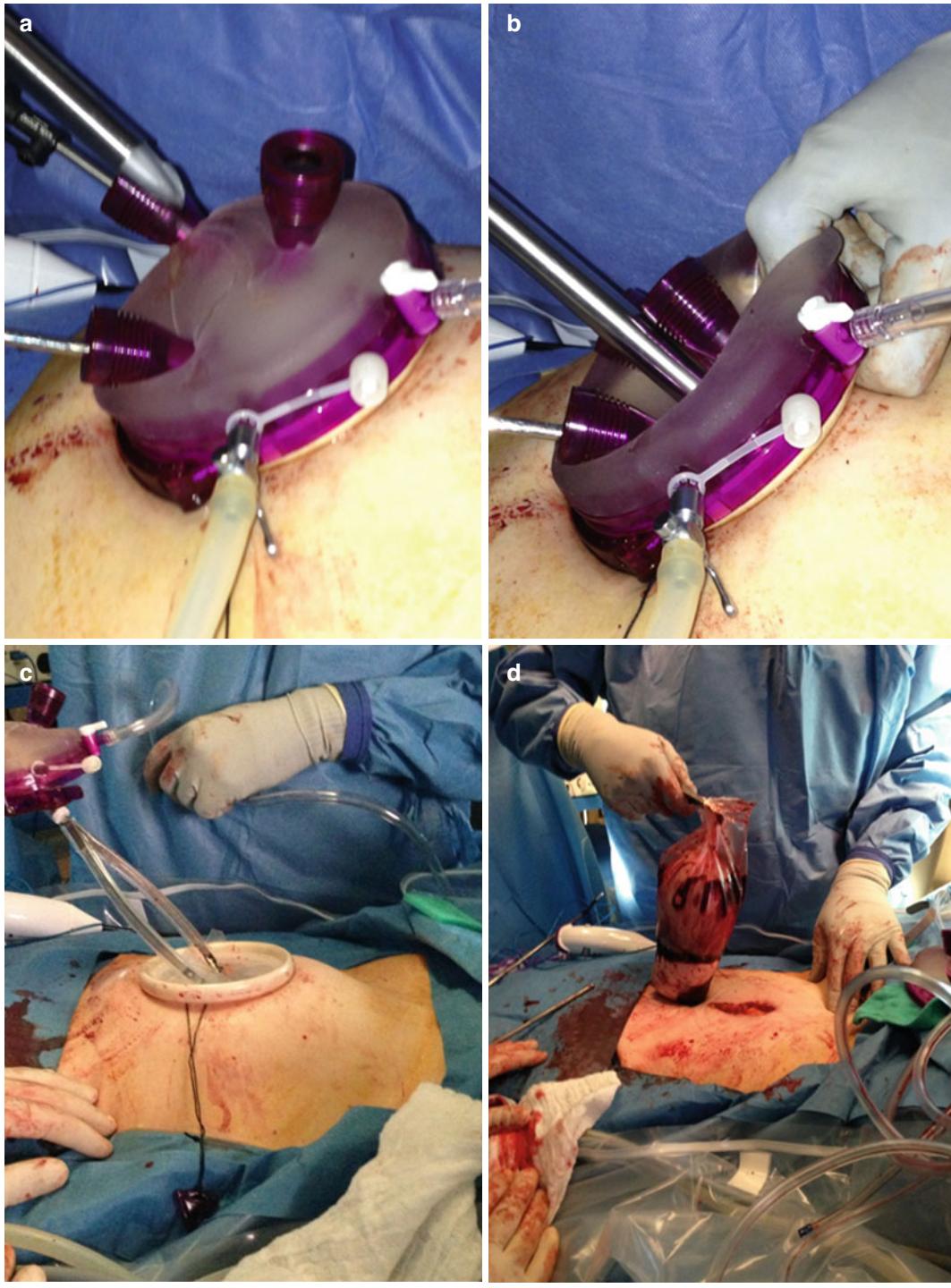

Fig. 10.1 Direct insertion of a large Endocatch bag through a Gel Point™ device (Applied Medical; Rancho Santa Margarita, CA). (**a**) The tip of the metal ring is advanced. (**b**) The bag is inserted directly through the gel. (**c**) Bag is cinched and metallic ring is withdrawn. (**d**) String is cut, gel cap removed, and specimen retrieved from the abdomen within the bag. Note that the incision in this case was extended to retrieve a very large, solid mass

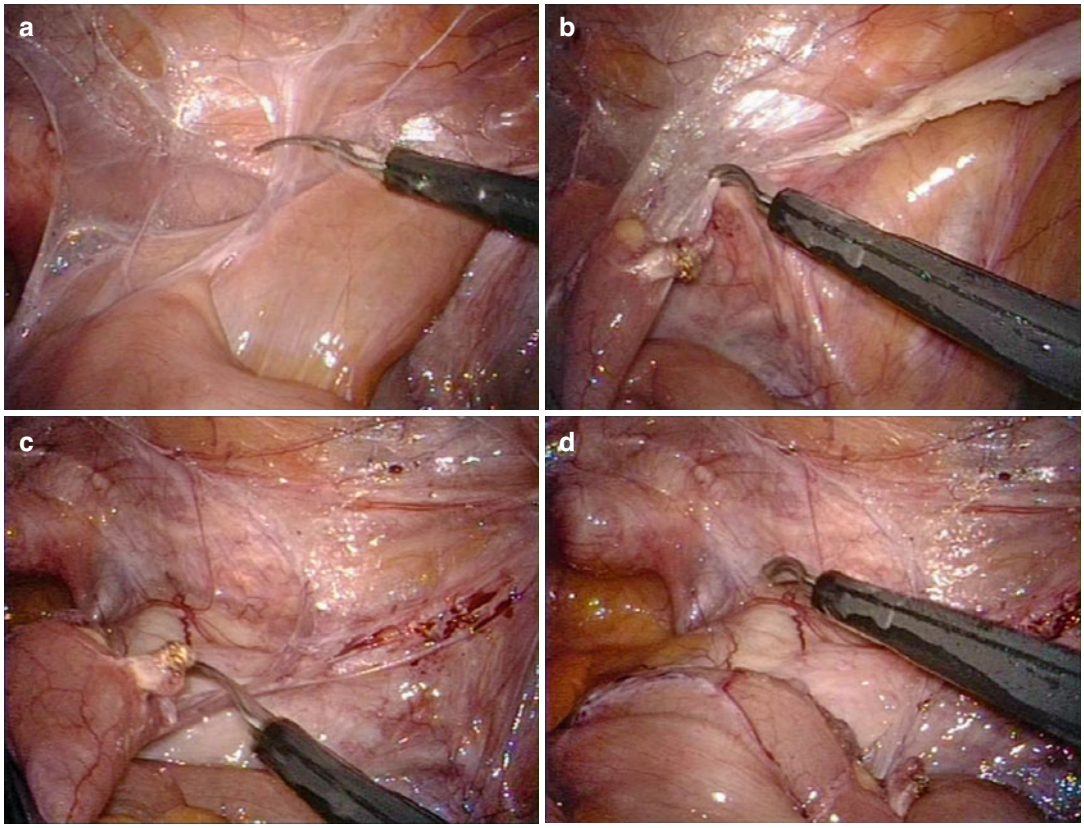

Fig. 10.2 Lysis of adhesions to expose adnexal mass using bowel grasper and endoscopic shears. (**a**) Lysis of filmy small bowel adhesions. (**b**) Cauterization of thick band and continued lysis of filmy adhesions. (**c**) Final lysis of small bowel adhesions. (**d**) Dissection of colon off of side wall to expose infundibulopelvic ligament

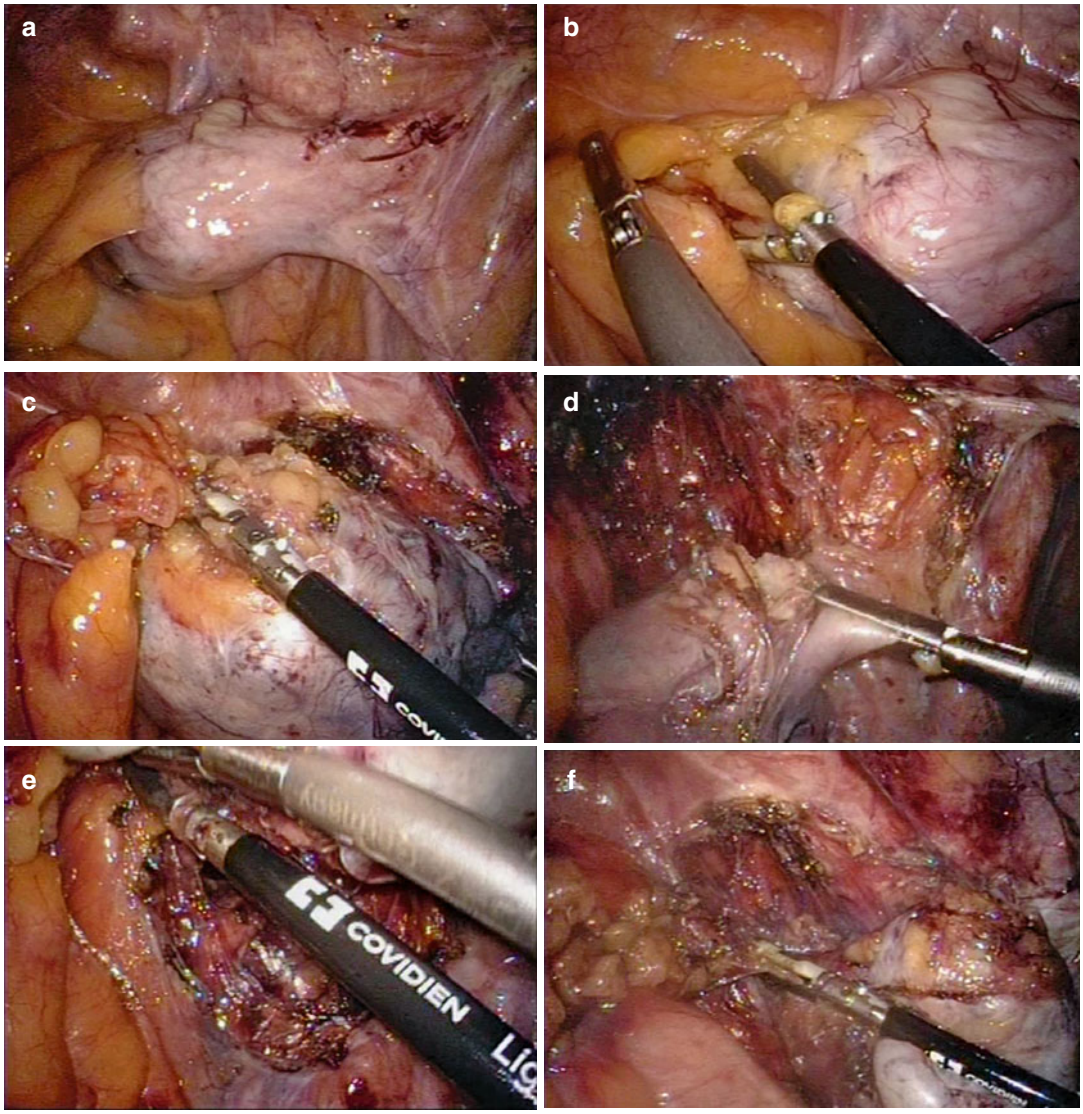

Fig. 10.3 Lysis of adhesions and excision of right ovarian fibroma. (**a**) Fibroma attached to sigmoid epiploica and side wall. Note ureter running posterior to anterior. (**b**) Lysis of epiploica adhesions. (**c**) Side wall open laterally and lower pole adhesions lysed. (**d**) Transection of infundibulopelvic ligament. (**e**) Mobilization away from the side wall. (**f**) Retrograde transection of inferior side wall attachments

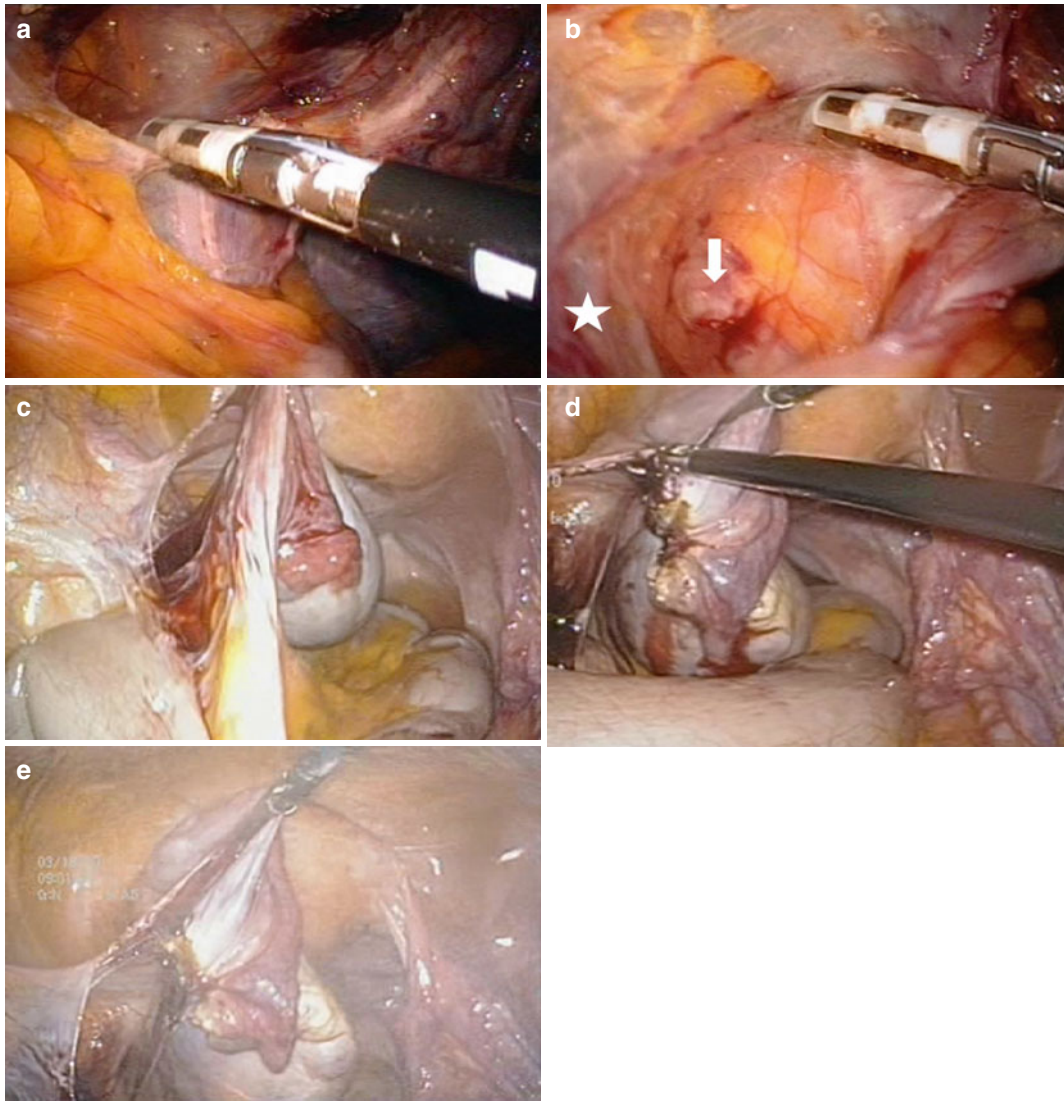

Fig. 10.4 Exposure of side wall and left salpingo-oophorectomy in patient with prior hysterectomy. (**a**) Opening of left pelvic side wall. (**b**) Exposure of iliac vessels (*star*) and ureter (*arrow*). (**c**) Traction on ovary to isolate infundibulopelvic ligament. (**d**) Transection of broad ligament. (**e**) Transection of distal side wall attachments

10.3 Procedure

The steps for single-port laparoscopic management of adnexal masses are listed in Table 10.4. Positioning is typically done as seen in Fig. 10.5. Most adnexal surgery is best performed via a transumbilical single-port approach. Entry into the peritoneal cavity should be carried out using the technique described by Hasson et al. [10]. Occasionally we have chosen an alternate site of entry, usually owing to a large uterus or a large adnexal mass, in which we make our incision in a supraumbilical location. Our preferred method of entry is to anesthetize the periumbilical region with bupivacaine. The edges of the umbilicus are grasped at 3 and 9 o'clock with Allis clamps, and we incise through the base of the umbilicus in the midline to make an incision measuring 1.5–2.5 cm. The fascial incision is extended, the peritoneum is grasped and entered, and a finger is swept into the peritoneal cavity to assess for adhesions. We then place an S-retractor into the peritoneal cavity at the inferior portion of the incision. The single-port system is then inserted into the peritoneal cavity and fixed in place, and the abdomen is insufflated. Once the camera is inserted into the peritoneal cavity, we use articulation of the flexible camera to evaluate the anterior abdominal wall around the port site and to evaluate the peritoneal cavity for ascites, carcinomatosis, and other pathology. The operative procedure itself can be carried out using standard, straight laparoscopic instruments (Fig. 10.6), but an increasing number of articulating instruments are available to decrease instrument clashing. The development of multifunctional instruments that enable us to dissect, seal vessels, and cut tissue without instrument exchanges has been a key to efficient single-port (and standard laparoscopic) procedures. Once the procedure is complete, we typically close the fascia with 0 delayed absorbable suture in a running fashion. If there was a previous umbilical hernia, we often use interrupted, figure-of-eight, nonabsorbable sutures. The skin is closed with a running subcuticular 4-0 absorbable suture.

Fig. 10.5 Patient positioning. Typical positioning used with patient in lithotomy, both arms tucked and padded at sides, shoulders padded with a "beanbag" deflated to conform to the patient. The chest is taped/strapped with padding beneath. The beanbag can also be taped to the table if extra support is needed

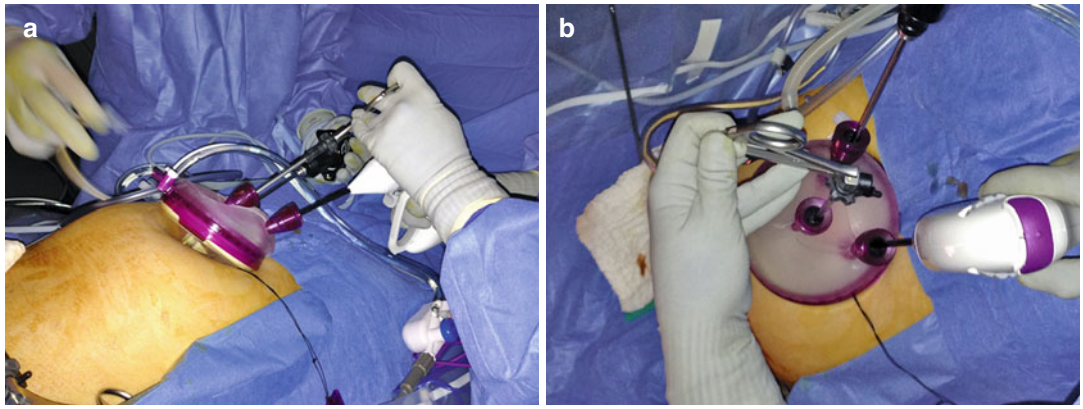

Fig. 10.6 Hand position in single-port laparoscopy with straight instruments. (**a**) Lateral view of hand positions. The nondominant hand (i.e., left) is toward the pelvis, with the handle of the instrument inverted. The dominant hand (i.e., right) is cephalad, with the instrument held in normal position. (**b**) Top view of hand positions. Note the port set-up of two ports cephalad and one caudad. The camera is in the right cephalad port

Table 10.4 Steps for single-port laparoscopic excision of an adnexal mass

Examination under anesthesia
Umbilical/abdominal entry via Hasson technique
Placement of single-port device and insufflation of abdomen
Inspection of mass and peritoneal surfaces, including diaphragm (easier with 30° or flexible-tip laparoscope)
Pelvic and abdominal washings
Biopsy of sites suspicious for metastasis; get frozen section
If malignant, convert to laparotomy for staging, if feasible; carry out laparoscopic staging, if it can be performed adequately; or discontinue laparoscopy and refer for staging
If benign/no evidence of malignancy, proceed with single-port laparoscopy
Cystectomy, oophorectomy, salpingectomy (excision of mass)
Identify ureter
Identify and ligate gonadal vessels for oophorectomy
If prophylactic bilateral salpingo-oophorectomy, ensure all ovarian tissue is removed, including adhesions—typically 2–3 cm up infundibulopelvic ligament from ovary
Place mass in laparoscopic specimen retrieval bag
Open bag at abdominal wall and remove specimen for frozen section
Inspect for hemostasis, irrigate, and close

10.4 Single-Port Laparoscopic Adnexal Surgery in Gynecology

10.4.1 Tubal Sterilization

One of the first reports on the use of single-port laparoscopy was for tubal sterilization. Wheeless and Thompson [3] reported on 2,600 women who underwent tubal sterilization at Johns Hopkins between 1968 and 1972, via a one-incision periumbilical technique utilizing either one burn or three burns using electrocautery through an operative laparoscope with an eyepiece. This technique was compared to a two-incision technique for sterilization in an additional 1,000 patients. Of the total of 3,600 patients, there were 24 pregnancies following the sterilization procedure. Injury of the intestinal tract from electrocautery occurred in 11 women. Miller [11] described single-puncture sterilization in an office setting using a single-puncture laparoscope with intravenous conscious sedation and local anesthesia in over 1,100 women. Ismail et al. [12] described a single-puncture tubal sterilization technique using Filshie clips in 42 women. More recently, Sewta [13] published a report on single-port laparoscopic sterilization using fallopian tube rings in 2011 patients in India. There were no sterilization failures and no major complications.

10.4.2 Management of Ectopic Pregnancy

Bedaiwy et al. [14] described the management of 11 hemodynamically stable women with isthmic and ampullary ectopic pregnancies using laparoendoscopic single-site salpingectomy using a commercially available single-port device. In this study, the tubal mass measured 1–6.5 cm and fetal cardiac activity was present in 6 of the 11 patients. The median operative time was 35 min and blood loss was 30 mL. They reported no conversions and no intraoperative or postoperative complications. Yoon et al. [15] described their experience with 20 women with ectopic pregnancy treated by single-port salpingectomy using a homemade "glove port." Outcomes in this series were similar, with no conversions in their series.

10.4.3 Management of Adnexal Masses

Increasing data have shown the utility of a variety of single-port laparoscopic techniques in the management of adnexal masses and other pathology (Table 10.5) [9, 16–25]. Risk-reducing salpingo-oophorectomy (RRSO) is an indication that appears favorable for laparoscopic management. Escobar et al. [16] described their initial experience with RRSO and found short operative times and no major complications in the RRSO group. Kim et al. [17] describe single-port access transumbilical laparoscopic-assisted adnexal surgery (SPATULAAS) for benign-appearing adnexal masses greater than 8 cm, using a homemade glove port. We have found that many adnexal masses up to 18 cm and some pedunculated leiomyomas with stalk width of $\leq$3 cm can be managed with a single port laparoscopic approach (Figs. 10.7 and 10.8).

Single-port access hand-assisted laparoscopic surgery (SPA-HALS) was developed for the management of large adnexal tumors Rho et al. [9] compared 43 patients with large adnexal tumors managed by SPA-HALS with 96 patients managed by standard single-port laparoscopic surgery (SPL). Despite a larger median mass size in the SPA-HALS group (10.9 vs. 6.3 cm), they noted a significant reduction in tumor spillage (10.3 % vs. 31.3 %) and more frequent adnexa-conserving procedures (76.7 % vs. 43.8 %) in the SPA-HALS group, compared with the standard SPL group.

Isobaric single-port laparoscopy has also been described using an abdominal wall elevator with a subcutaneous surgical wire or "rope" and steep Trendelenburg to visualize the pelvis without the use of pneumoperitoneum. This technique has been used for a variety of procedures on the ovaries and in the management of ectopic pregnancy

[26–28]. The number of applications for single-port laparoscopy in the management of adnexal pathology continues to grow and will only be limited by the gynecologist's imagination and skill set.

Although culdoscopy enjoyed popularity in the 1950s and 1960s, its use is more limited today. However, there are still papers published detailing transvaginal management of a variety of adnexal and uterine pathology. Tsin and colleagues [29] described a variety of surgical procedures performed via transvaginal laparoscopy, including ovarian cystectomy, oophorectomy, myomectomy, appendectomy, and cholecystectomy. There were no major complications in their series, but reported bowel injury rates for a transvaginal approach have ranged from 0.25 to 0.65 % [30]. In their retrospective review, 22 of 24 injuries resolved with conservative management consisting of hospital observation and antibiotics.

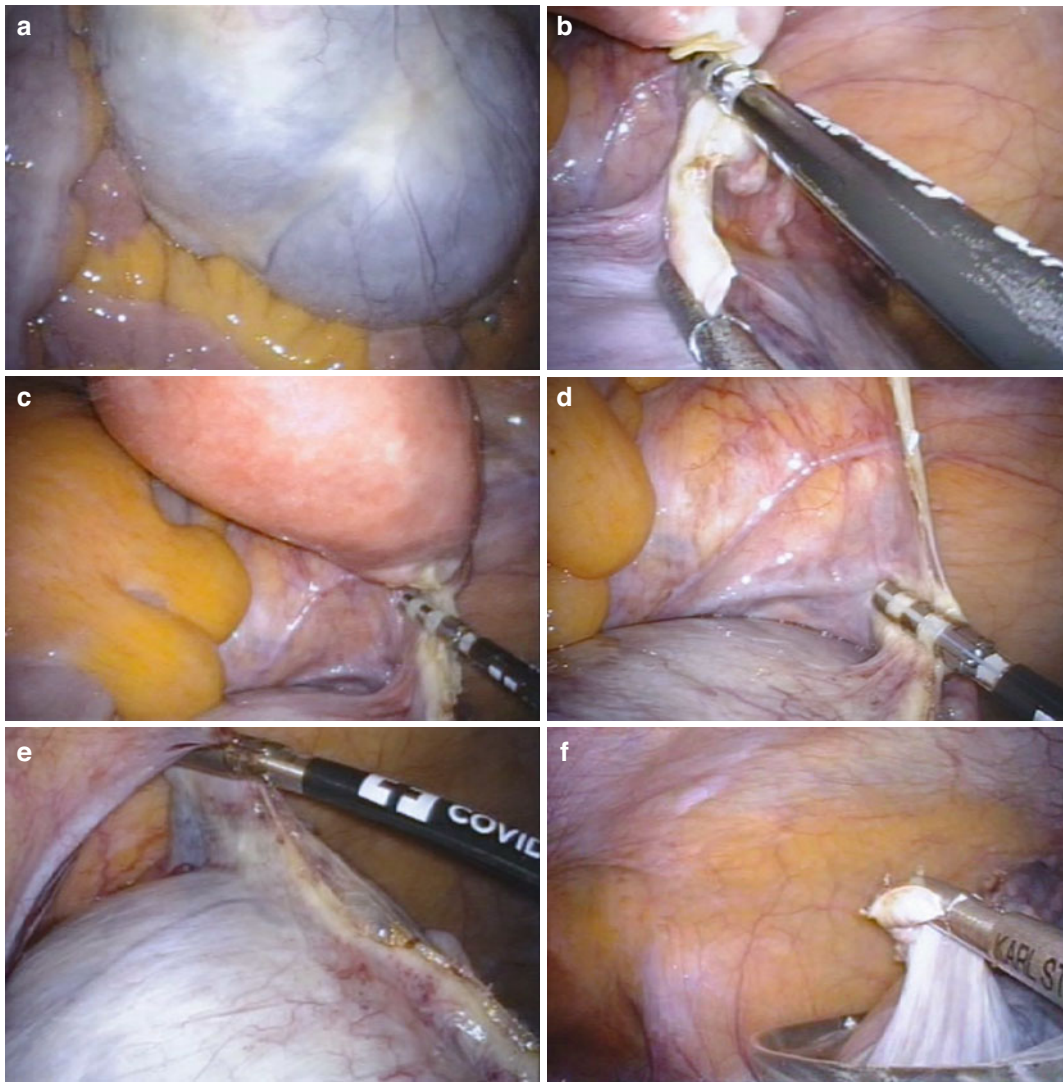

Fig. 10.7 Retrograde excision of 15-cm right ovarian mass. (**a**) 15-cm mass in situ. (**b**) Transection of proximal tube. (**c**) Transection of utero-ovarian ligament. (**d**) Transection of upper broad ligament. (**e**) Transection of infundibulopelvic ligament. (**f**) Placement of specimen into 15-mm specimen retrieval bag

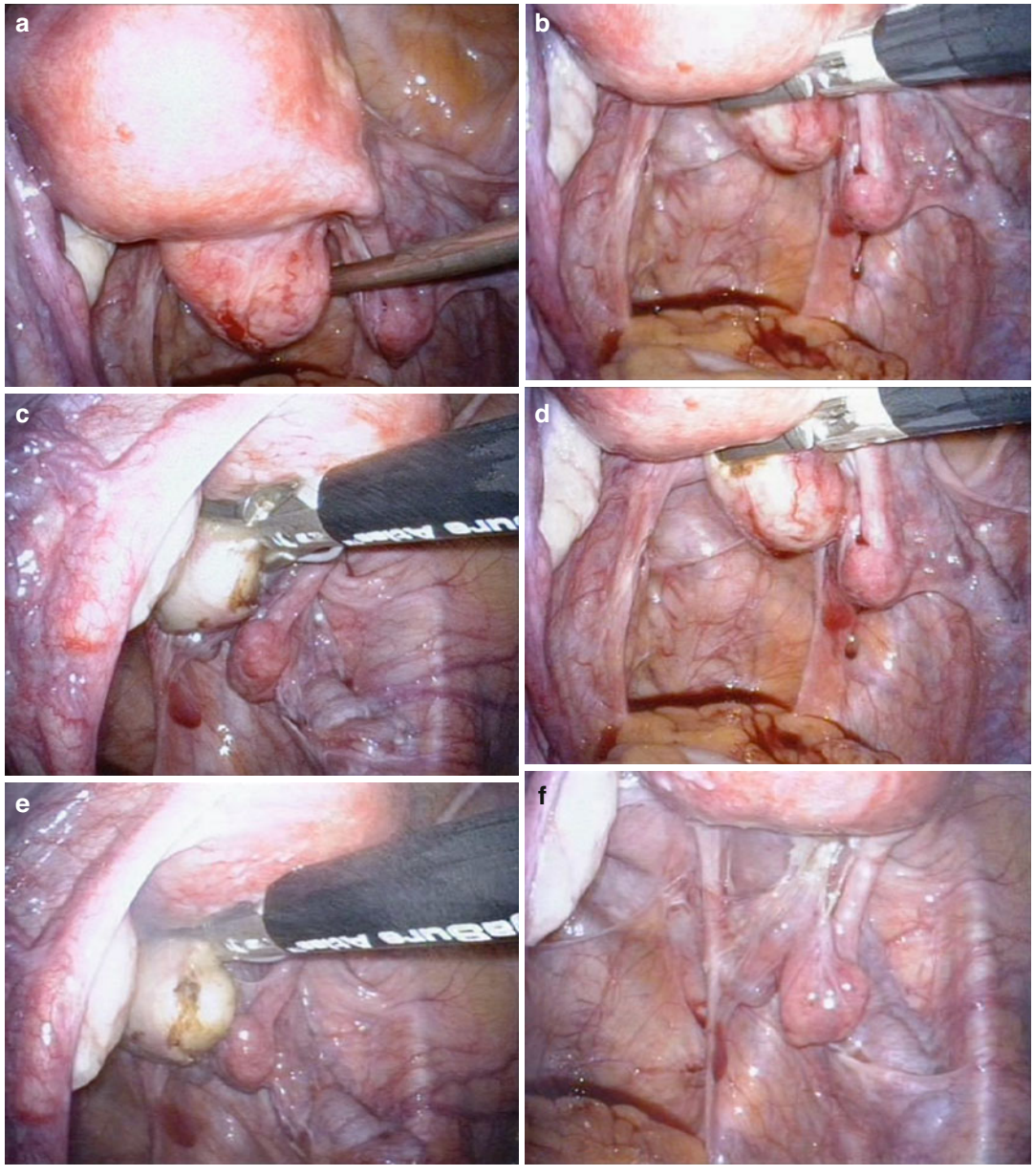

Fig. 10.8 Excision of pedunculated leiomyoma. (**a**) Pedunculated leiomyoma. (**b**) 10-mm Ligasure (Covidien, Mansfield, MA) used with slow closure of jaws on several cauterization cycles. (**c**) Energy active and jaws being closed slowly. (**d**) Complete closure of jaws. (**e**) Transection of last pedicle. (**f**) Leiomyoma completely excised

Table 10.5 Studies on single-port laparoscopy for adnexal mass

Study	Year	Cases, *n*	Mean tumor diameter, *cm*	Notes
Kim et al. [18]	2009	24	5.0	LESS successful in 92 %, 1 case added trocar for adhesions, 1 conversion for LMP tumor. Median operative time 70 min. No major complications
Escobar et al. [19]	2010	8	5.3	1 conversion, 1 additional 3-mm trocar for adhesions
Escobar et al. [16]	2010	58	n/a	LESS risk-reducing salpingo-oophorectomy, 13 cases also had hysterectomy. Wound cellulitis in 1.7 %. No umbilical hernias
Lee et al. [20]	2010	17	5.6	No differences in operative time, pain, or EBL compared with 34 patients undergoing laparoscopic procedures. Majority had cystectomy. No complications
Jung et al. [21]	2011	86	n/a	Majority of cases for endometriosis; 4 complications (3 pelvic infections, 1 postop hemorrhage); 2 converted to multiport laparoscopy. Safe and feasible
Kim et al. [17]	2011	94	6.3	Homemade glove port, single surgeon, 2 conversions for possible cancer, 2 cases with extra trocar for lysis of adhesions, No major complications
Bedaiwy et al. [22]	2012	28 (50 controls)	5.5	Compared with 50 control standard laparoscopies. Safe, feasible: similar EBL, operative time, hospital stay
Cho YJ et al. [23]	2012	33	6.6	Compared single-port and conventional laparoscopic cystectomy for adnexal mass. 1 postop ileus and 1 ovarian hematoma in single-port group. No conversion. No comment on cyst rupture rates
Gunderson et al. [24]	2012	70	n/a	70/211 cases for adnexal masses. Overall 2.4 % (3/70) umbilical hernia risk
Roh et al. [9]	2012	43	10.9	Single-port hand-assisted laparoscopy for large tumors; 10.3 % spill, 0 % hernia
Hoyer-Sorenson et al. [25]	2012	20	All <6 cm	Compared with 20 control standard laparoscopies. Higher rate of shoulder tip pain in SPL group at 6 and 24 h. Similar use of analgesics

EBL estimated blood loss, *LESS* laparoendoscopic single-site surgeries, *LMP* low malignant potential, *SPL* single-port laparoscopy

10.5 Complications

Expected complications are similar to those for standard laparoscopy, such as visceral injury, port-site hernia, and tumor rupture (Table 10.6) [8, 9, 17, 18, 20, 22, 31–35]. However, the risk of umbilical (port-site) hernia has been a major concern with increasing the size of the umbilical access site. Standard laparoscopic approaches have noted increasing umbilical hernias with increased size of the umbilical port size. Given that most standard laparoscopic procedures would use a port size of up to 10–12 mm with a typical umbilical hernia rate of 1–3 % [36, 37], concern has been that increasing the umbilical incision to 20–25 mm may increase the hernia risk. Most single-port laparoscopy studies in the gynecology literature have noted umbilical hernia risk up to 2.4 % [6, 24]. Based on early data, visceral injury and increased blood loss do not appear to be any more frequent with single-port laparoscopy. The rate of cyst rupture varies between studies and by definition of rupture, as some authors perceive only gross leakage of cyst fluid as a spill, whereas others feel that any breach in the cyst wall would count. Overall rates appear to be about 20 % with laparoscopy, but they do vary widely based on definitions. Moreover, it appears that rupture risk is increased with cystectomy versus oophorectomy, and it increases with the size of the mass [38].

Table 10.6 Complications of single-port laparoscopic management of adnexal masses

Year	Study	Cases, *n*	Mean size, *cm*	Mean operative Time, *min*	EBL, *mL*	Cyst rupture, %	Umbilical hernia	Cellulitis or abscess	Visceral injury	Comments
2009	Kim et al. [18]	24	5	70	10	NR	0	0	0	1 additional trocar for adhesiolysis, 1 conversion for LMP tumor
2010	Lee et al. [20]	17	5.6	64	80	NR	0	0	0	Compared with 34 CL cases, similar operative time, pain, EBL
2010	Mereu et al. [32]	16	–	42	<10	NR	0	1 (6.2 %)	0	Reusable port and curved graspers
2011	Im et al. [33]	18	8.3	62.8	100	NR	0	0	0	No conversions. 7 mild postop fever
2011	Kim et al. [8]	22	11.9	50	38	9.1	0	0	0	Extracorporeal cystectomy or cyst drainage. Fever 9 %. 1 extra trocar for adhesiolysis
2011	Kim et al. [17]	94	6.3	50	83	10.7	0	0	0	95 % successful SPL (2 conversion, 2 extra trocars)
2012	Bedaiwy et al. [22]	28	5.5	45	20	NR	0	0	0	Operative time, EBL similar to standard laparoscopy. Less postop narcotic use in SPL
2012	Fagotti et al. [34]	125	6.0	48	10	NR	0	1 (0.8 %)	0	3 additional ports used: 2 for control of bleeding, 1 to remove large specimen. Learning curve = 15 procedures
2012	Kim et al. [35]	94	5.0	77.5	50	NR	0	NR	NR	Compared to CL. 49 % prior abdominal surgery. 6 cases had additional trocars placed. Less pain in SPL group at 24 h
2012	Roh et al. [9]	96 (SPL)	6.3	70	105	31.3	0	1 (1 %)	0	1 umbilical wound infection and 2 ileus in SPL group
		43 (hand- assist)	10.9	75	50	10.3	0	0	0	

CL conventional laparoscopy, *EBL* estimated blood loss, *LMP* low malignant potential, *NR* not recorded, *SPL* pure single-port laparoscopy

Conclusions

Single-port laparoscopic management of the adnexa in gynecology is safe and feasible. With continued advances in technology, the instrumentation will become easier to use, and increasing dissemination of this knowledge and equipment will allow single-port laparoscopy to become more readily available to a larger number of gynecologic surgeons. In benign gynecology, a large number of cases should be amenable to minimally invasive approaches, whether single-port or conventional laparoscopy, but increased availability of novel technologies should not replace sound clinical judgment and surgeon comfort in deciding which patients should undergo single-port laparoscopic procedures. A focused approach to increasing the number of minimally invasive cases in one's practice can lead to a successful decline in the number of open procedures performed and subsequently can decrease postoperative complications. Certainly many adnexal masses should be amenable to laparoscopic excision. Further data should help to clarify whether single-port laparoscopic cystectomy and oophorectomy have any higher risk of tumor rupture and whether the outcome is affected for women found to have ovarian cancer.

References

1. TeLinde RW, Rutledge F. Culdoscopy, a useful gynecologic procedure. Am J Obstet Gynecol. 1948;55: 102–16.
2. Christian J, Barrier BF, Schust D, et al. Culdoscopy: a foundation for natural orifice surgery–past, present, and future. J Am Coll Surg. 2008;207:417–22.
3. Wheeless Jr CR, Thompson BH. Laparoscopic sterilization. Review of 3600 cases. Obstet Gynecol. 1973; 42:751–8.
4. Ghezzi F, Cromi A, Bergamini V, et al. Should adnexal mass size influence surgical approach? A series of 186 laparoscopically managed large adnexal masses. BJOG. 2008;115:1020–7.
5. Fader AN, Rojas-Espaillat L, Ibeanu O, et al. Laparoendoscopic single-site surgery (LESS) in gynecology: a multi-institutional evaluation. Am J Obstet Gynecol. 2010;203:501.e1–6.
6. Lee M, Kim SW, Nam EJ, et al. Single-port laparoscopic surgery is applicable to most gynecologic surgery: a single surgeon's experience. Surg Endosc. 2012;26:1318–24.
7. Im SS, Gordon AN, Buttin BM, et al. Validation of referral guidelines for women with pelvic masses. Obstet Gynecol. 2005;105:35–41.
8. Kim WC, Im KS, Kwon YS. Single-port transumbilical laparoscopic-assisted adnexal surgery. JSLS. 2011;15:222–7.
9. Roh HJ, Lee SJ, Ahn JW, et al. Single-port-access, hand-assisted laparoscopic surgery for benign large adnexal tumors versus single-port pure laparoscopic surgery for adnexal tumors. Surg Endosc. 2012;26: 693–703.
10. Hasson HM, Rotman C, Rana N, Kumari NA. Open laparoscopy: 29-year experience. Obstet Gynecol. 2000;96:763–6.
11. Miller GH. Office single puncture laparoscopy sterilization with local anesthesia. JSLS. 1997;1:55–9.
12. Ismail MT, Arshat H, Halim AJ. Filshie clip sterilization – single puncture laparoscopic approach (a preliminary report). Malays J Reprod Health. 1988;6: 90–6.
13. Sewta RS. Laparoscopic female sterilisation by a single port through monitor – a better alternative. J Indian Med Assoc. 2011;109:262–3, 266.
14. Bedaiwy MA, Escobar PF, Pinkerton J, Hurd W. Laparoendoscopic single-site salpingectomy in isthmic and ampullary ectopic pregnancy: preliminary report and technique. J Minim Invasive Gynecol. 2011;18:230–3.
15. Yoon BS, Park H, Seong SJ, et al. Single-port laparoscopic salpingectomy for the surgical treatment of ectopic pregnancy. J Minim Invasive Gynecol. 2010; 17:26–9.
16. Escobar PF, Starks DC, Fader AN, et al. Single-port risk-reducing salpingo-oophorectomy with and without hysterectomy: surgical outcomes and learning curve analysis. Gynecol Oncol. 2010;119:43–7.
17. Kim WC, Lee JE, Kwon YS, et al. Laparoscopic single-site surgery (LESS) for adnexal tumors: one surgeon's initial experience over a one-year period. Eur J Obstet Gynecol Reprod Biol. 2011;158:265–8.
18. Kim TJ, Lee YY, Kim MJ, et al. Single port access laparoscopic adnexal surgery. J Minim Invasive Gynecol. 2009;16:612–5.
19. Escobar PF, Bedaiwy MA, Fader AN, et al. Laparoendoscopic single-site (LESS) surgery in patients with benign adnexal disease. Fertil Steril. 2074;2010(93):e7–10.
20. Lee YY, Kim TJ, Kim CJ, et al. Single port access laparoscopic adnexal surgery versus conventional laparoscopic adnexal surgery: a comparison of perioperative outcomes. Eur J Obstet Gynecol Reprod Biol. 2010;151:181–4.
21. Jung YW, Choi YM, Chung CK, et al. Single port transumbilical laparoscopic surgery for adnexal

lesions: a single center experience in Korea. Eur J Obstet Gynecol Reprod Biol. 2011;155:221–4.
22. Bedaiwy MA, Starks D, Hurd W, Escobar PF. Laparoendoscopic single-site surgery in patients with benign adnexal disease: a comparative study. Gynecol Obstet Invest. 2012;73:294–8.
23. Cho YJ, Kim ML, Lee SY, et al. Laparoendoscopic single-site surgery (LESS) versus conventional laparoscopic surgery for adnexal preservation: a randomized controlled study. Int J Womens Health. 2012;4:85–91.
24. Gunderson CC, Knight J, Ybanez-Morano J, et al. The risk of umbilical hernia and other complications with laparoendoscopic single-site surgery. J Minim Invasive Gynecol. 2012;19:40–5.
25. Hoyer-Sørensen C, Vistad I, Ballard K. Is single-port laparoscopy for benign adnexal disease less painful than conventional laparoscopy? A single-center randomized controlled trial. Fertil Steril. 2012;98:973–9.
26. Takeda A, Imoto S, Mori M, et al. Wound retraction system for isobaric laparoendoscopic single-site surgery to treat adnexal tumors: pilot study. J Minim Invasive Gynecol. 2010;17:626–30.
27. Takeda A, Imoto S, Mori M, et al. Isobaric laparoendoscopic single-site surgery with wound retractor for adnexal tumors: a single center experience with the initial 100 cases. Eur J Obstet Gynecol Reprod Biol. 2011;157:190–6.
28. Ülker K, Hüseyinoğlu Ü, Kılıç N. Management of benign ovarian cysts by a novel, gasless, single-incision laparoscopic technique: keyless abdominal rope-lifting surgery (KARS). Surg Endosc. 2013;27:189–98.
29. Tsin DA, Colombero LT, Lambeck J, Manolas P. Minilaparoscopy-assisted natural orifice surgery. JSLS. 2007;11:24–9.
30. Gordts S, Watrelot A, Campo R, Brosens I. Risk and outcome of bowel injury during transvaginal pelvic endoscopy. Fertil Steril. 2001;76:1238–41.
31. Jansen FW, Kolkman W, Bakkum EA, et al. Complications of laparoscopy: an inquiry about closed- versus open-entry technique. Am J Obstet Gynecol. 2004;190:634–8.
32. Mereu L, Angioni S, Melis GB, Mencaglia L. Single access laparoscopy for adnexal pathologies using a novel reusable port and curved instruments. Int J Gynaecol Obstet. 2010;109:78–80.
33. Im KS, Koo YJ, Kim JB, Kwon YS. Laparoendoscopic single-site surgery versus conventional laparoscopic surgery for adnexal tumors: a comparison of surgical outcomes and postoperative pain outcomes. Kaohsiung J Med Sci. 2011;27:91–5.
34. Fagotti A, Bottoni C, Vizzielli G, et al. Laparoendoscopic single-site surgery (LESS) for treatment of benign adnexal disease: single-center experience over 3-years. J Minim Invasive Gynecol. 2012;19:695–700.
35. Kim TJ, Lee YY, An JJ, et al. Does single-port access (SPA) laparoscopy mean reduced pain? A retrospective cohort analysis between SPA and conventional laparoscopy. Eur J Obstet Gynecol Reprod Biol. 2012;162:71–4.
36. Coda A, Bossotti M, Ferri F, et al. Incisional hernia and fascial defect following laparoscopic surgery. Surg Laparosc Endosc Percutan Tech. 2000;10:34–8.
37. Kadar N, Reich H, Liu CY, et al. Incisional hernias after major laparoscopic gynecologic procedures. Am J Obstet Gynecol. 1993;168:1493–5.
38. Smorgick N, Barel O, Halperin R, et al. Laparoscopic removal of adnexal cysts: is it possible to decrease inadvertent intraoperative rupture rate? Am J Obstet Gynecol. 2009;200:237.e1–3.