13 Single-Port Laparoscopic Hysterectomy

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Introduction

Since the late 1980s and early 1990s, surgeons have been vigorously exploring minimally invasive techniques to decrease the complication rates of traditional hysterectomy when vaginal hysterectomy is not an option, and this led to the development and advancement of conventional laparoscopic hysterectomy. For the past 10–15 years, access and instrumentation for laparoscopic hysterectomy has improved, but the techniques have been relatively unchanged. Although still minimally invasive options, the conventional laparoscopic and robotic hysterectomy techniques typically require 3–5 small incisions in the abdominal wall. Each additional port contributes a small but not negligible risk for port site complications [1]. Besides, every surgical incision carries an inherent risk of infection, bleeding, or potential for visceral injury as well as an effect on cosmetic results. In an effort to minimize risks including postoperative pain and improve cosmesis, alternatives to traditional laparoscopic surgery are being explored. Several centers are investigating techniques that gain access to the peritoneal cavity via natural orifices using a specialized endoscope and therefore do not require any abdominal wall incisions. Natural orifice transluminal endoscopic surgery (NOTES) has been described in animal models and in humans [2, 3]. A less dramatic and perhaps less risky approach is to perform laparoscopic surgery through a single port in the abdominal wall. The advent of multichannel ports for laparoscopy has enabled surgeons to complete laparoscopic surgeries through a single small incision that can be hidden in the base of the umbilicus. Other technological advances have been the development of articulating cameras and articulating surgical instruments.

Several retrospective studies suggest the potential for decreased pain with single-port laparoscopy; however, two randomized controlled trials have conflicting results [4, 5]. Fagotti et al. showed lower postoperative pain in patients undergoing single-port procedures, while Jung et al. found no evidence of reduction in postoperative pain. Pontis et al. [6] conducted a meta-analysis of RCTs that compared single-site to multi-port gynecologic surgeries. They reported that single-port approach did not offer the expected advantages in postoperative pain or cosmetic results. In a systematic review and meta-analysis in 2017, Sandberg et al. [7] found that

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compared to conventional multi-port laparoscopic hysterectomy, the single-port technique is feasible, effective, and safe for performing benign hysterectomy. The authors did not identify any clinically relevant advantages and concluded that there is no reason to recommend wide implementation of single-port hysterectomy. Nevertheless, the technique continues to be offered as an alternative access technique for hysterectomy and benign gynecologic surgery. Since its first description, several authors around the world have used multiple terms to describe laparoscopy carried out via a single incision. A multispecialty international consortium has recommended the name Laparo-Endoscopic Single-Site Surgery (LESS) [1, 8]. Nevertheless, a list of the multiple terms still being used is listed Table 13.1.

Potential drawbacks of LESS include a larger umbilical incision with higher risk of port site herniation, lack of triangulation of operative instruments, technical challenges due to inherent proximity/crowding of instruments leading to internal and external clashing, and increase in operative time during the learning curve. In addition, it is not clear if LESS is cost-effective as there may be costs involved in implementing a new technology with the need to purchase new supplies (camera, instruments, and ports) [7]. Although not common, it is reported that in 3.5% of LESS hysterectomies, an additional port is required counting as a "failure of the single-site approach" [7]. The first LESS procedure was reported in 1969 with the first LESS hysterectomy performed by Pelosi et al. in 1991 [9, 10]. There are no national data on the proportion of hysterectomies performed using a LESS technique [7].

Table 13.1 Terms and abbreviations used to describe LESS

eNOTES
Embryonic natural orifice transluminal endoscopic surgery
LESS
Laparoendoscopic single-site surgery
NOTUS
Natural orifice transumbilical surgery
OPUS
One-port umbilical surgery
SAS
Single-access site laparoscopic surgery
SILS
Single-incision laparoscopic surgery
SPA
Single-port access laparoscopic surgery
SPLS
Singe-port laparoscopic surgery
SSA
Single-site access laparoscopic surgery
SSL
Single-site laparoscopy
TUES
Transumbilical endoscopic surgery
TULA
Transumbilical laparoscopic assisted surgery
U-LESS
Transumbilical laparoendoscopic single-site surgery

Adapted from Tracy et al. [1]

The objective of this chapter is to illustrate an effective, efficient, and reproducible technique to perform LESS for hysterectomy. The basic concepts illustrated here can be further utilized in any pelvic surgery. This technique is easily understood, replicated, and useful in learning the LESS technique for hysterectomy. Escobar et al. examined the learning curve for LESS and found similar results when compared to published conventional laparoscopy learning curves [11]. Although many of these techniques work well for complex surgical cases, we strongly recommend surgeons become familiar with the technique first for benign indications and ovary preservation. Complex situations such as endometriosis, large fibroid uteri, malignancy, and significant adhesions are not addressed and are for advanced LESS surgeons. We describe a technique for surgeons who are interested in learning the LESS technique. Understanding the procedure and technique described here will help the surgeon proceed efficiently resulting in minimal instrument exchanges and external and internal clashing and avoiding a frustrating experience.

Instrumentation

There are specialized articulating instruments available. This may be helpful in certain situations; however, there is a learning curve to using those articulating instruments. When learning a new technique, we suggest minimizing the number of learning curves as much as possible. Using

the technique described below, the majority of cases can be performed using only conventional straight instrumentation available in all operating rooms.

Camera Options

Most experts agree an articulating camera is preferred and can sometimes facilitate an efficient procedure (Fig. 13.1b). However, bariatric length or longer, 30-degree or 45-degree, laparoscopes can also be successful using the techniques and principles described here. If a non-articulating laparoscope is used, we recommend a 90-degree adaptor be used to minimize interference with the light cord (Fig. 13.1a and inset).

Technical Principles

1. Plan the procedure and chose instrumentation and techniques that minimize the need for instrument exchanges.
2. Always retract in such a way to that the handle of the instrument moves lateral, away from the camera and central area above the umbilicus. This prevents clashing of instruments externally.
3. Use a good uterine manipulator with colpotomizer or ring to delineate the vaginal fornix.
4. If significant difficulty is encountered at any time during the procedure, an additional port can always be considered.

Ports and Gaining Access

Various access devices and techniques have been described for peritoneal access. The skin incision should be created to provide the most cosmetic result possible. The umbilicus itself is a scar and each has unique folds and shape. In some patients, a vertical skin incision may be preferred. In others, a circumferential or "omega" incision may produce a better cosmetic result [12]. General surgeons also use this incision to provide additional space to manipulate multiple laparoscopic instruments while providing ample space for specimen removal and maintaining excellent cosmesis [13, 14]. Some have raised concerns regarding umbilical infections; a retrospective study of 120 patients did not find a difference in rate of infection when comparing vertical to circumferential umbilical incision for LESS [12]. As with all laparoscopy, we advocate thorough attention to the umbilicus during the surgical preparation prior to surgery. Overly limiting the size of the incision may place excess pressure on the incision edges that may result in pressure necrosis at the edge of the incision. Although this condition usually heals

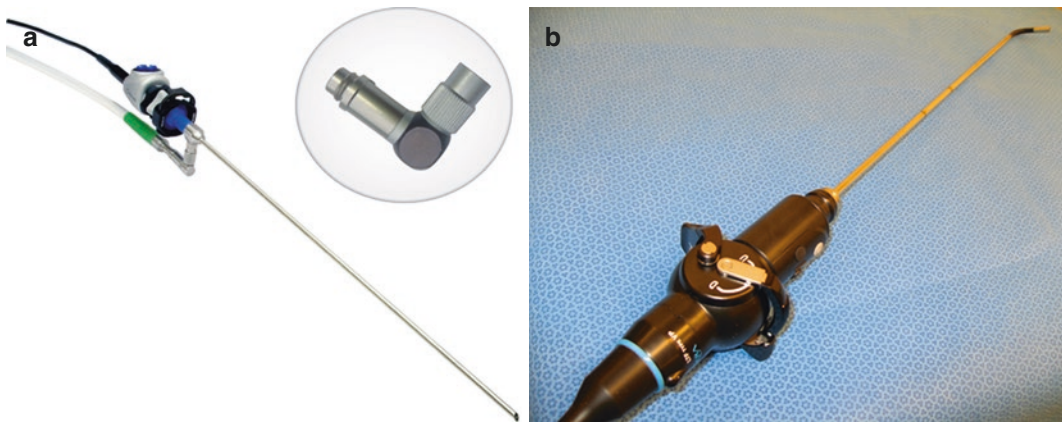

Fig. 13.1 Laparoscope options. (**a**) 30-degree or 45-degree laparoscopes work well for LESS. The longer and more angled the scope, the better to minimize external clashing. A inset: A 90-degree light cord adaptor will minimize interference with the light cord and other instruments. (**b**) An articulating scope provides excellent ability to position the camera away from other instruments. (Pictured, EndoEye™ (Olympus Surgical & Industrial America Inc., Center Valley, PA))

well, this should be considered when making the skin incision and choosing ports for each patient.

There are a number of commercially available ports designed to be placed through a single fascial incision (Fig. 13.2).

Fig. 13.2 (**a**) The X-CONE™ (Storz Endoscopy, Tuttlingen, Germany). (**b**) AnchorPort ® SIL Kit device (Surgiquest Inc., Orange, CT). (**c**) SILS™ Port (Covidien, Norwalk, CT). (**d**) GelPoint™ (Applied Medical, Rancho Santa Margarita, CA). (**e**) TriPort Plus™ (Advanced Surgical Concepts, Wicklow, Ireland). (**f**) TriPort 15™ (Advanced Surgical Concepts, Wicklow, Ireland)

A. The X-CONE™ (Storz Endoscopy, Tuttlingen, Germany) (three 5-mm valves).
B. AnchorPort ® SIL Kit device (Surgiquest Inc., Orange, CT) (allows 3 or more 5-mm trocars through a 1-in. skin incision).
C. SILS™ Port (Covidien, Norwalk, CT) (three 5-mm cannulas, one of which can be upsized to 15 mm).
D. GelPoint Mini™ (Applied Medical, Rancho Santa Margarita, CA) (includes four 5–12-mm universal cannulas. Additional instruments can be placed as needed).
E. TriPort Plus™ (Advanced Surgical Concepts, Wicklow, Ireland) (three 5-mm and one 10-mm channel).
F. TriPort 15™ (Advanced Surgical Concepts, Wicklow, Ireland) (two 5-mm and one 15-mm channel, respectively).

Most commercially available ports have two attachments that can be used for insufflation, outflow, smoke evacuation, or an additional insufflation port as necessary.

Ports that make use of a single open fascial incision maximize space for additional instruments. However, ports that have multiple channels/cannulas minimize instrument friction and unintended crossing at the level of the fascia at the expense of needing a slightly larger fascial incision.

When necessary, an additional port can always be placed at an alternate location to facilitate the procedure. Conversion to two-port or multiport conventional laparoscopy should not be considered a complication.

Technique

What follows is a step-by-step outline for an efficient procedure. The temptation will be to skip steps or alter the order. We cannot stress enough the importance of completing the first step before moving on to the next. This will eliminate extraneous or duplicative movements. It also will ensure that instruments are positioned away from each other and avoid clashing – both internally and externally.

Step 1: Initial Port Placement and Orientation

The surgeon should choose the port based on the individual characteristics of the patient, the case, surgeon preference and experience, and the advantages and disadvantages to the specific ports. The ports should be placed in accordance with the manufacturer's instructions for use. Once securely placed in the peritoneal cavity, the port should be oriented as in Fig. 13.3. The chan-

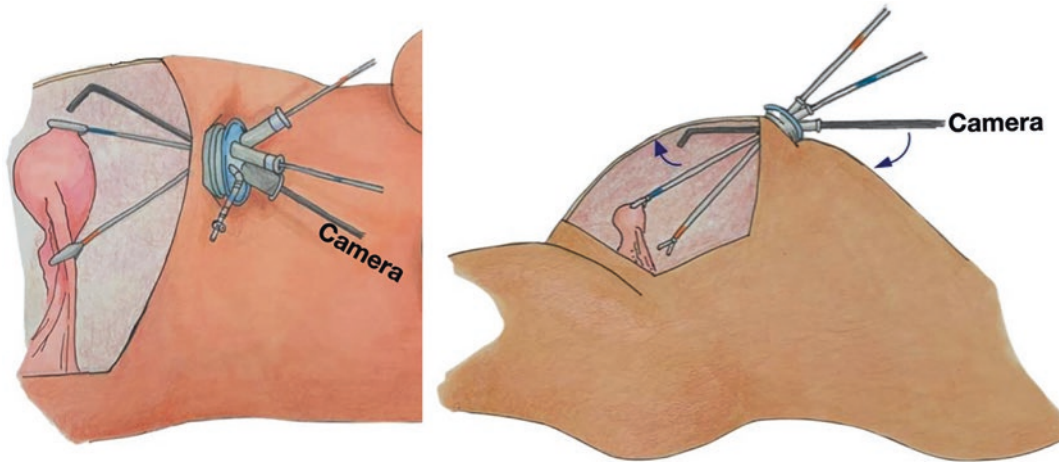

Fig. 13.3 Port orientation and camera placement. Port should be oriented so that the laparoscope may be placed through the most cephalad channel, valve, or cannula

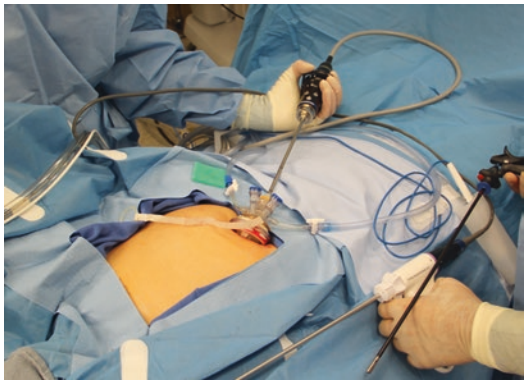

Fig. 13.4 Camera placement. The camera should be placed first prior to any additional instruments. The camera should be placed close to the chest and deviated lateral to maximize space for additional instruments

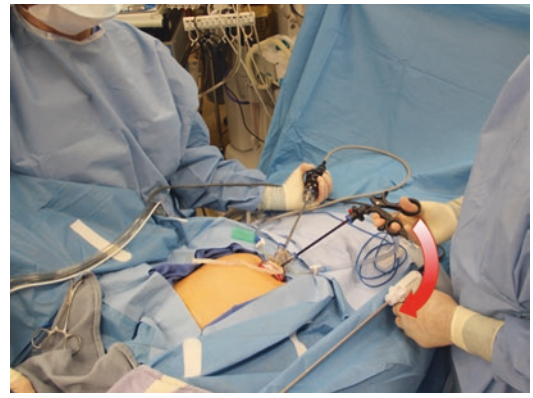

Fig. 13.5 Insert the assistant grasper. Retraction should always be in the direction such that the handle moves lateral, away from the midline

nels or valves should be oriented so that the laparoscope can be placed through the most cephalad channel. The laparoscope should be positioned so that externally, the camera will be placed as close to the chest as possible. Then position the camera laterally as much as practical (Fig. 13.4). This places the camera low and lateral maximizing space for other instruments and the primary surgeon's hands directly above the port. With the hands and camera close to the chest, this will elevate the internal end of the laparoscope toward the anterior abdominal wall. Internally, this positions the laparoscope anterior and out of the way for additional instruments within the pelvis. The greater the angle of the scope (30-degree, 45-degree, or flexible), the easier it is to get the laparoscope and camera away from the operative field and avoid clashing.

Step 2: Insert the Assistant Instrument/Grasper

Here we assume the primary surgeon is on the patient's left side and will begin the hysterectomy on the patient's left. (This process could be reversed if standing on the opposite side.) An assistant grasper instrument is inserted through the *left* channel and controlled with the surgeon's left hand (Fig. 13.5). The technical principle should be maintained: the direction of traction should always be to move the instrument handle away from midline externally. Retract or manipulate the tissue internally so the handle falls lateral and away from the camera. This maximizes room for the laparoscope and instrument handles externally. A good uterine manipulator will be able to adequately elevate and position the uterus toward the right shoulder. The assistant grasper can be used to augment and maximize this positioning to present the left uteroovarian and broad ligaments for the electrosurgical device (Fig. 13.6).

Step 3: Insert the Operating Electrosurgical Instrument

The operating instrument will be inserted through the *right* channel (Fig. 13.7). It will enter the internal operative field through the center and usually be directed straight toward the uteroovarian ligament. It is often easier to begin by sealing and transecting the uteroovarian ligament leaving the ovaries until after the hysterectomy is completed (Fig. 13.6). This allows the ovaries to remain on the pelvic sidewall, away from the uterus, and out of the way. After the hysterectomy is completed, the ovaries can be simply removed if desired. In the event the instrument handles interfere with each other or the camera, the handles should be positioned opposite of each other (Fig. 13.8).

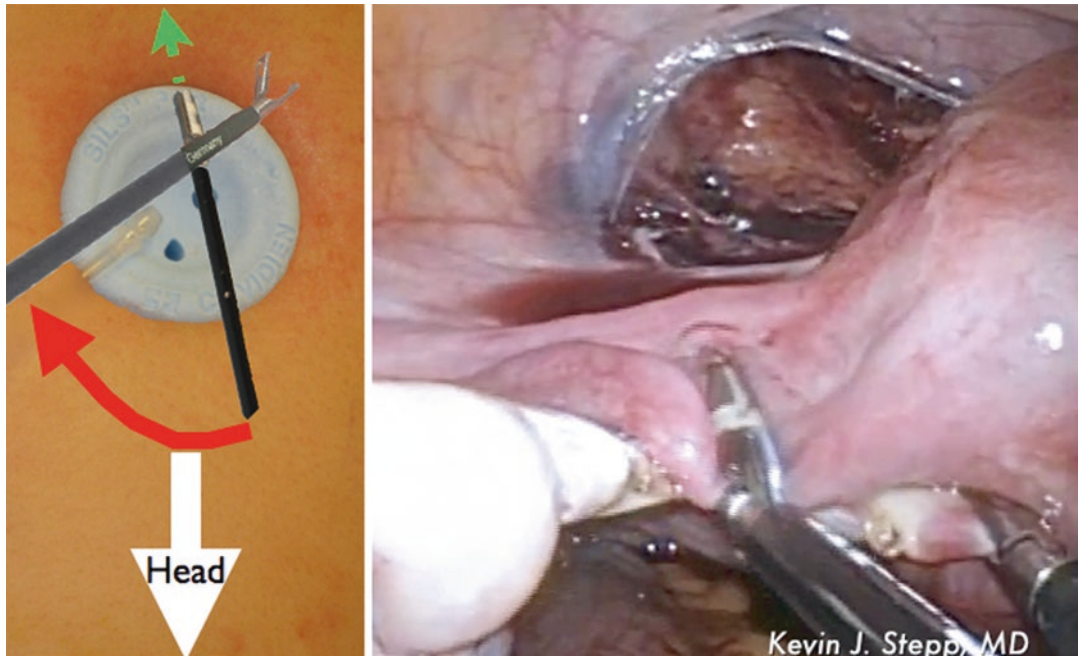

Fig. 13.6 Begin the left side of the hysterectomy. The assistant grasper and uterine manipulator deviate the uterus to the contralateral side providing excellent position for the bipolar device to begin the hysterectomy

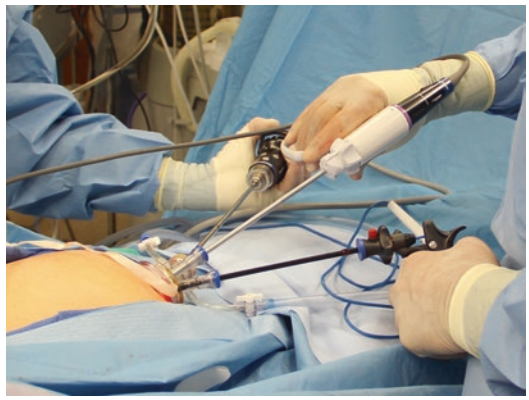

Fig. 13.7 External view showing set-up and instrument positions without clashing. Note the handles of the bipolar device and assistant grasper are facing opposite directions

Fig. 13.8 External view showing camera low and a comfortable surgeon position with handles of instruments facing outward

Step 4: Perform the Left Side of the Hysterectomy

Grasp and seal the utero-ovarian ligament with the electrosurgical device. Continue to seal and transect the broad ligament until beyond the round ligament. Separate the broad ligament to begin to expose the uterine vessels (Fig. 13.9). Separating the anterior and posterior leaves of the broad ligament too soon will cause bleeding from the round ligament. Upward traction on the uterine manipulator exposes the uterine vasculature and increases the distance to the ureters. If the uterine vessels are clearly visible, they may be sealed at this time; inside the ring/cup of the uterine manipulator will provide a safe distance from the ureters to avoid lateral electrosurgery injury (Fig. 13.10).

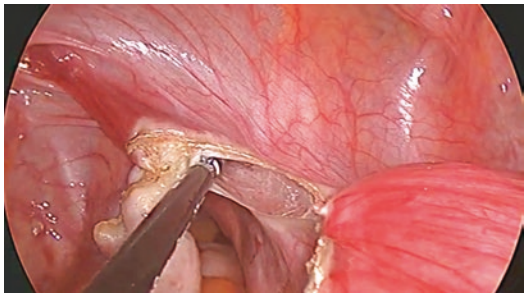

Fig. 13.9 Once the round ligament is completely sealed, begin to separate the anterior and posterior broad ligament to expose the uterine vasculature and begin the bladder flap

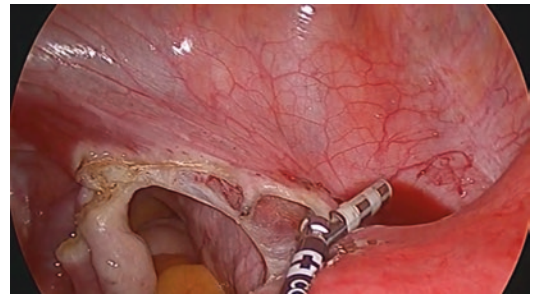

Fig. 13.11 Creating the bladder flap. Often the bladder flap is created with the bipolar instrument. Opening the jaws and rotating will help get around the front of the uterus

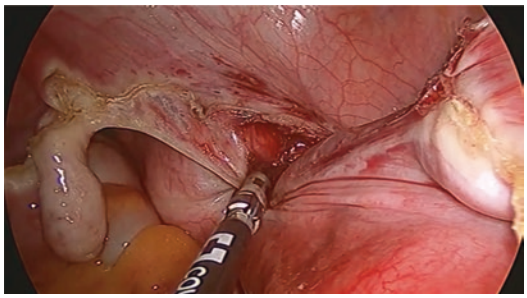

Fig. 13.10 The uterine vasculature is sealed, while upward traction is placed on the uterine manipulator. The bipolar device should stay inside the colpotomizer ring/cup of the uterine manipulator to minimize risk of ureter injury

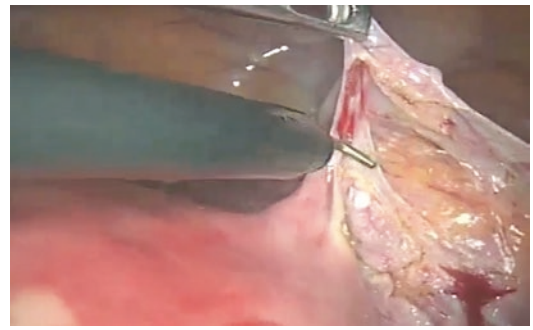

Fig. 13.12 Creating the bladder flap. An alternate method involves elevation of the anterior bladder peritoneum in the midline while incising the peritoneum to expose the vaginal cuff and fornix

Step 5: Create the Bladder Flap

The assistant grasper now can be moved inferiorly on the uterus if necessary. Alternatively, the assistant grasper may elevate the bladder peritoneum cephalad and upward toward the anterior wall. Ideally, the assistant grasper will also be used to elevate the bladder peritoneum thus minimizing instrument exchanges. If necessary, rotation of the open jaws of the energy device will provide an additional few millimeters toward the right side (Fig. 13.11).

Variation: If necessary, the operative instrument/energy device can be exchanged with a monopolar/bipolar hook or spatula to create the bladder flap (Fig. 13.12). Remove the hook or spatula when the bladder flap is complete.

Step 6: Perform the Right Side of the Hysterectomy

Early in one's learning curve, we believe the simplest option for the right side is to remove both the assistant grasper and the operative instrument/energy device. The primary surgeon can move to the patient's contralateral side (Fig. 13.14) or remain on the patient's left side (Fig. 13.15). The uterus should be repositioned toward the left with the manipulator. Then steps 2–5 should be performed from the right side/opposite directions.

Reinsert the assistant grasper from the *right* channel and retract lateral (Fig. 13.13) while deviating the uterus toward the left shoulder. Insert the electrosurgical instrument through the

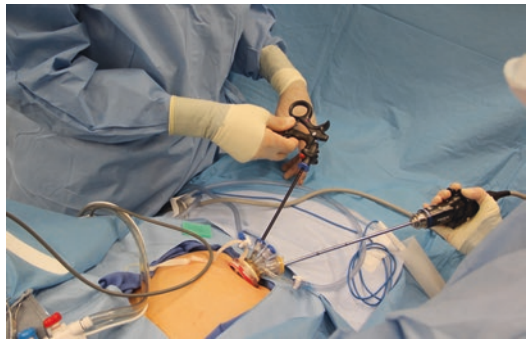

Fig. 13.13 Performing the right side of the hysterectomy. In this view, the primary surgeon has switched sides and is now on the patient's right side. The camera is positioned on the contralateral side. All instruments are removed to set up the operative technique again. The assistant grasper is placed through the *right* channel and the handle retracted laterally

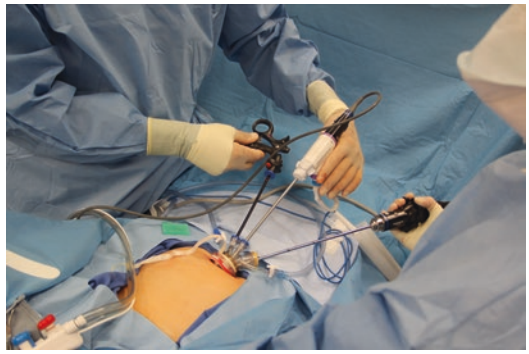

Fig. 13.14 Insert the bipolar device to perform the right side of the hysterectomy. Note the handles are not clashing with each other or the camera

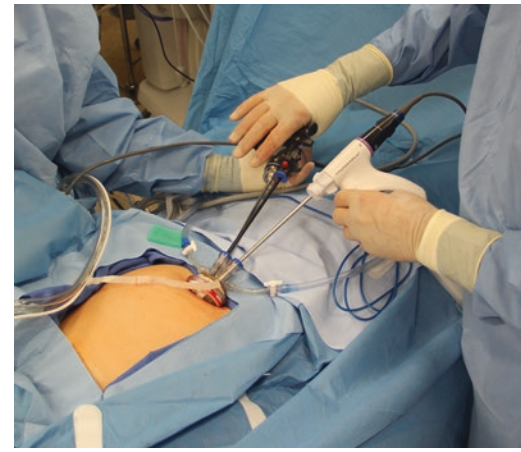

Fig. 13.15 Performing the right side of the hysterectomy without switching sides. The instruments are still switched as in Fig. 13.14. However, the primary surgeon remains on the patient's left side. To maintain a comfortable position requires the surgeon to place the bipolar device in his/her left hand

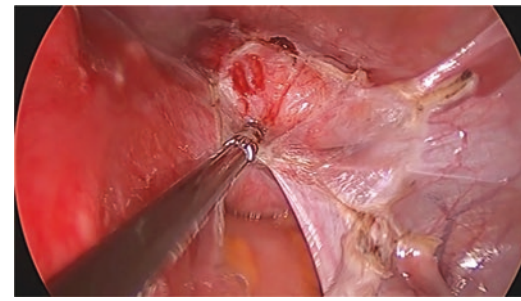

Fig. 13.16 Sealing the right uterine vasculature with upward traction on the uterine manipulator. The bladder flap is completed if necessary

left channel (Figs. 13.14 and 13.15). Seal and transect the uteroovarian ligament, round ligament, and broad ligament. Complete the bladder flap from the right side. Expose and seal the right uterine vessels (Fig. 13.16).

Step 7 (Supracervical Hysterectomy): Amputate the Fundus

Position the uterus toward the right shoulder with the uterine manipulator. Remove the assistant grasper and operative instrument. Move the assistant grasper to the contralateral channel on the *left* and insert. Grasp the uterine fundus or place posteriorly behind cervix to elevate the uterus toward the right shoulder and away from bowel. The instrument handle will fall laterally to the left and down away from the camera. Insert a monopolar/bipolar hook or spatula through the contralateral (*right*) channel for amputation (Fig. 13.17). The instrument should appear midline as it approaches the lower uterus (Fig. 13.18).

Complete 50% of the amputation from the left side (Fig. 13.19). Continued and increasing upward traction on the uterus with the assistant grasper will create a reverse cone ensuring maximal resection of the internal cervical os. To complete the amputation from the right side,

reposition the uterus to the right with the uterine manipulator, and repeat the steps from the contralateral side: Remove the assistant grasper and operative instrument. Place the assistant grasper now through the *right* channel and create the upward traction by grasping the uterine fundus or by placing the instrument posteriorly behind the cervix. Elevate the uterus toward the left shoulder and away from bowel by placing handle laterally to the right and down away from camera. Reinsert the monopolar/bipolar hook or spatula via the *left* channel to complete the amputation. Coagulate the endocervix.

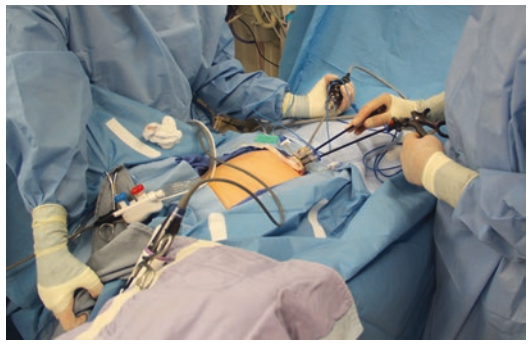

Fig. 13.17 Set-up for supracervical amputation or colpotomy. The assistant grasper handle is retracted laterally providing space for the hook or spatula without clashing or touching other instruments. The assistant can comfortably manipulate the uterus and the camera for exposure

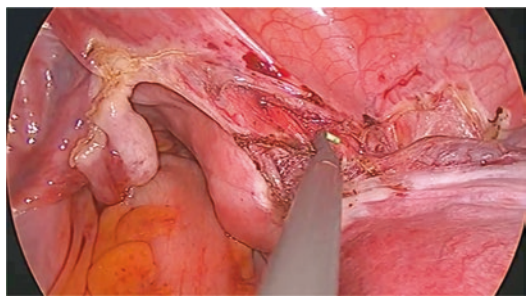

Fig. 13.18 Internal view of a monopolar hook beginning the supracervical amputation on the left

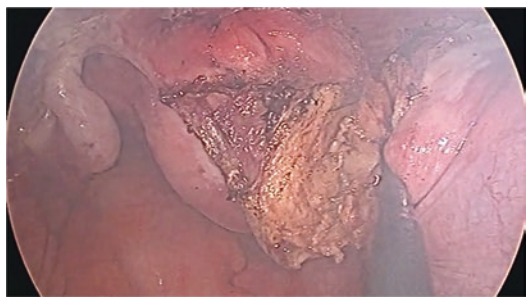

Fig. 13.19 Internal view of amputation. The left side is completely amputated before proceeding to the contralateral side to minimize going back and forth

Step 7 (Total Laparoscopic Hysterectomy): Perform the Colpotomy

This procedure is very similar to the supracervical amputation technique. Careful positioning of the uterus to expose the cervicovaginal junction will allow efficient creation of the colpotomy with limited instrument exchanges.

The external position of the instruments and hands are similar to supracervical amputation (Fig. 13.17).

With the uterus positioned to the right with the uterine manipulator, place the assistant grasper now through the *left* lateral channel, and grasp the uterine fundus or place posteriorly behind cervix to elevate the uterus toward the right shoulder and away from bowel. Insert a monopolar/bipolar hook or spatula through the contralateral channel to start the colpotomy (Fig. 13.20). Complete 50% of the amputation from the left side.

Fig. 13.20 Internal view of the colpotomy. Upward traction will increase the distance from the ureters laterally and help identify the colpotomizer ring/cup of the uterine manipulator. Begin the colpotomy anteriorly and proceed laterally and posteriorly as much as possible before proceeding to the contralateral side

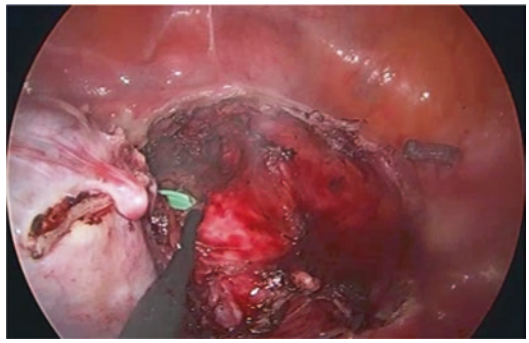

Fig. 13.21 The colpotomy is then completed on the right side staying medial to the sealed uterine vessels

To complete the amputation from the right side, reposition the uterus to the left with the uterine manipulator and repeat the process from the contralateral side (Fig. 13.21). Occasionally it may be necessary to reposition the uterus anteriorly to complete the colpotomy in the posterior midline.

Step 8 (Total Laparoscopic Hysterectomy): Vaginal Cuff Closure

In the case of total hysterectomy, the authors suggest closing the vaginal cuff from a vaginal approach. Laparoscopic suturing is the most complicated task to perform with LESS. We recommend traditional suturing be considered only by those well experienced with LESS. If laparoscopic closure is attempted, we suggest utilizing suture-assisting devices such as Endostitch (Covidien, Norwalk, CT), barbed suture, and Laparo-Ty (Ethicon EndoSurgery, INC. Cincinnati, OH).

Risks Specific to LESS

As with any laparoscopy, it is imperative that surgeons have thorough knowledge of electrosurgery to avoid electrosurgical complications. Surgeons should be aware of the different types of electrosurgical complications. There may be a theoretical increased risk of capacitive coupling when performing LESS. Working with instruments in close quarters may predispose them to insulation damage. Therefore, we recommend meticulous inspection of the instruments. Disposable electrosurgical instruments may have decreased risk of insulation damage and thus lower risk of direct coupling. We believe good technique should mitigate these risks. LESS is a feasible and safe alternative to traditional multiport conventional laparoscopy in selected patients.

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