

## INTRODUCTION

Hysterectomy is the most commonly performed major gynecologic procedure around the world. Benign diseases are responsible for more than 70% of the indications for hysterectomy and include menstrual disorders, fibroids, pelvic pain and uterine prolapse.<sup>(1)</sup>

Traditionally, hysterectomy is performed by laparotomy or by vaginal access. In 1989, Reich et al. (1989) described the first totally laparoscopic hysterectomy, which is currently considered an alternative means of access to traditional techniques for hysterectomy.<sup>(2,3)</sup>

Despite the advantages of the laparoscopic and vaginal routes compared with laparotomy, this remains the most widely used access route for performing hysterectomy worldwide. In Denmark, 80% of hysterectomies for benign disease between 1988 and 1998 were performed by laparotomy. In the period between 1988 and 1990, approximately 1.7 million hysterectomies were performed in the United States and 75% were by the abdominal route. In 2003, 538,722 hysterectomies were performed for benign disease in the United States and the abdominal route was still the most common (66.1%), followed by vaginal (21.8%) and laparoscopic routes (11.8%).<sup>(4,5)</sup>

A survey done at French university hospitals for women who underwent hysterectomy for benign disease revealed that total laparoscopic hysterectomy was performed in 19.1%, laparoscopic assisted vaginal hysterectomy in 8.2%, total abdominal hysterectomy in 24.4% and vaginal hysterectomy in 48.3%, showing a significant reduction in the rate of laparotomies for performing hysterectomies.<sup>(5)</sup> This trend indicates an adaptation to the modern concept of minimally invasive surgery. In some referral centers for gynecological laparoscopy in France, such as Clermont-Ferrand, the rate of total laparoscopic hysterectomy is up to more than 90%.<sup>(6)</sup>

The advantages of the laparoscopic approach compared to open surgery include less intraoperative bleeding, shorter hospital stay, faster recovery and lower rates of wound and / or abdominal wall infections, at the expense of a longer surgery. Although it has been demonstrated an increased rate of ureteral and bladder injuries with the laparoscopic access, a recently published series including 4505 women undergoing hysterectomy using different routes of access (laparoscopy, laparotomy and vaginal) showed no statistically significant difference in the rate of major complications when the 3 groups were compared.<sup>(7,8)</sup>

### **Laparoscopic vs. open vs. vaginal hysterectomy**

There are several studies in the literature comparing the different routes of access to perform hysterectomy. A meta-analysis comparing women undergoing total abdominal hysterectomy and total laparoscopic hysterectomy observed a reduction in the rate of intraoperative and postoperative complications (30.1% vs. 9.2%) and in the intraoperative blood loss. There was no statistically significant difference in the rate of major complications (2.9% vs. 4.1%), which included bladder injury, ureteral injury, bowel injury, vaginal vault dehiscence and pulmonary thromboembolism. Surgical time was significantly longer in the laparoscopic surgery, exceeding the laparotomy group by 22 minutes. A systematic review included seven randomized controlled studies comparing the quality of life for women after laparoscopic and abdominal hysterectomy, observed that the

laparoscopic procedure had a quality of life equal to or above the laparotomy procedure.<sup>(9,10,11)</sup>

A Cochrane review which compared the access routes for hysterectomy included 34 studies with a total of 4495 women. The benefits of laparoscopic surgery compared with open surgery were early return to usual activities (mean difference of 13.6 days), lower intraoperative blood loss (mean difference of 45ml), smaller drop in hemoglobin (mean difference of 0.55g/dl), shorter hospital stay (mean difference of 2 days) and lower incidence of fever and abdominal wall infections (OR 0.31), at the expense of a higher incidence of lesions of the urinary tract (bladder and ureter) (OR 2.41) and prolonged operative time (mean difference of 20.3 minutes). There was no evidence of benefit when comparing the laparoscopic and vaginal hysterectomy; the surgical time (mean difference of 39.3 minutes) and substantial bleeding (OR 2.76) were higher in the laparoscopic group.<sup>(12)</sup>

A study compared the hysterectomy performed by laparoscopy (n = 43), vaginal (n = 87) and abdominal routes (n = 103), noting that the vaginal route had the shortest operative time (130 vs. 90 vs. 115 minutes; respectively;  $p < 0.01$ ), but the greater intraoperative blood loss (200 vs. 300 vs. 250ml, respectively;  $p = 0.07$ ). The laparoscopic group had less need for analgesics (1.5 vs. 2 vs. 4 days, respectively;  $p < 0.01$ ).<sup>(13)</sup>

Evaluating the clinical and economic outcomes of laparoscopic, vaginal and open abdominal hysterectomy, a study observed that the rate of postoperative infection was higher in the group undergoing abdominal surgery (15% vs. 14% vs. 18%, respectively;  $p < 0.05$ ), length of hospital stay was shorter in the laparoscopic group (1.6 vs. 2.2 vs. 3.7 days;  $p < 0.001$ ) and the cost of the procedure was higher in the group undergoing surgery by open approach (\$10,868.00 vs. \$9544.00 vs. \$12,086.00, respectively;  $p < 0.05$ ).<sup>(14)</sup>

### **Total laparoscopic vs. laparoscopic supracervical hysterectomy**

Some authors have preferred to conserve the cervix at the time of hysterectomy. Urinary and sexual function after surgery, were the clinical parameters for comparison between the total and supracervical techniques. Early studies reported better sexual and urinary function after supracervical hysterectomy, however randomized controlled trials have not confirmed these findings. In a Cochrane review in 2006, a group of randomized controlled trials were evaluated with respect to the results of supracervical and total hysterectomy.<sup>(6)</sup> No difference in urinary incontinence, constipation and sexual function was noted. Sexual function was measured by satisfaction with sex life, the prevalence of dyspareunia and rate of general sexual problems. The supracervical group had lower febrile morbidity and higher cyclic bleeding 1 year after surgery (OR 11.31, 95% CI 5.1 to 31.2). The surgery time (mean difference of 11.41 minutes, 95% CI 6.6 to 16.3) and blood loss (mean difference of 85.1 ml, 95% CI 27.4 to 142.9) were lower in the supracervical group, but there was no difference in the need for blood transfusion. These studies included in the Cochrane review compared the supracervical hysterectomy and total hysterectomy performed through laparotomy, but have been extrapolated to the laparoscopy.<sup>(15,16,17)</sup>

Although cancer risk is low, the presence of dysplasia would be a contraindication for cervical preservation. Moreover, the risk of cyclical bleeding after surgery should be considered when discussing the removal of the cervix during a hysterectomy. The bleeding rates are between 5% and 20%, based on data obtained in randomized controlled studies of

hysterectomies done by laparotomy and 19% in a prospective observational study of cases done by laparoscopy. The rate of reoperation for cyclic bleeding is 1-2%. The endocervical fulguration has been shown to decrease the rate of future bleeding, although the efficacy of this modality has not been proven. Another option is excision of the endocervical component, but there is a paucity of literature or data on this technique.<sup>(17,18,19)</sup>

### **Open Hysterectomy:**

Pre-operative preparation is similar in both open and laparoscopic hysterectomies and entails anesthesia assessment, shaving and fasting. Anesthesia assessment include investigations (complete blood count CBC, bleeding time BT, CT clotting time, serum creatinine Cr, Serum hepatic enzymes SGO/PT and fasting blood sugar FBS) and airway assessment with or without chest X-ray (CXR) and electrocardiogram (ECG).

Hysterectomy operation include 7 steps; opening of the anterior abdominal wall, ligation of the round ligaments, ligation of the infundibulopelvic ligaments medial or lateral to the ovary , uterine arteries ligation, removal of the uterus, closure of the stump and lastly closure of the anterior abdominal wall in layers. The previously mentioned steps were for supracervical hysterectomy; but in total hysterectomy we add a step of cervical branch ligation after securing the uterine arteries.

During the 1940s, SCH was replaced almost universally by TAH because of the risk of cervical stump cancer and persistent blood-stained discharge associated with retaining the cervix. More recently, there has been a re-emergence of SCH, as some literature has suggested that retaining the cervix offers better postoperative sexual and urinary function and may protect the integrity of the pelvic floor. In the United States, the number of SCHs appears to be increasing simultaneously with a decrease in TAH.

The superiority of SCH over TAH still remains largely theoretical and is not supported by a review of evidence. There is no advantage of the supracervical hysterectomy with regards to surgical complications, urinary symptoms or sexual function for women undergoing hysterectomy for symptomatic uterine leiomyomata or abnormal uterine bleeding. Although supracervical hysterectomy may be associated with less blood loss and a shorter surgical time, these parameters have not been found to be clinically significant, and supracervical hysterectomy should not be recommended as a superior technique to total abdominal hysterectomy for the prevention of peri- and postoperative complications.<sup>(20-24)</sup>

### **Preoperative preparation**

#### **Particulars of laparoscopic hysterectomy**

The indications for laparoscopic hysterectomy are similar to those for hysterectomy in general. Specific indications for the laparoscopic approach are the cases where there is contraindication for vaginal hysterectomy .The Cochrane review that compared the results of abdominal, vaginal and laparoscopic hysterectomy concluded that the vaginal route of access should be preferred to abdominal access route, based on the best results. The authors also concluded that when vaginal hysterectomy is not possible, laparoscopic

hysterectomy can obviate the need for an abdominal hysterectomy, but require a longer surgical time (mean difference of 25.3 minutes), without imposing any additional benefit to the vaginal route of access.<sup>(6,19)</sup>

### **Contraindications**

The contraindications for laparoscopic hysterectomy are as follows:

- Medical conditions that contraindicate the establishment and maintenance of the pneumoperitoneum.
- Inexperience and / or inadequate training of surgeons.
- Malignancy that may require removal of the intact specimen or special procedures that can not be done due to skill, access or other circumstances.
- Lack of proper equipment.
- Contraindication to a possible laparotomy or non-acceptance of the patient. The consent form must include the potential need for conversion to laparotomy.<sup>(17)</sup>

### **Preoperative details**

Randomized studies have shown a decrease in surgical site infection with the use of prophylactic antibiotics in potentially contaminated procedures and it is recommended in cases of laparoscopic hysterectomy. The prophylactic antibiotics should be administered within one hour of incision in the skin and should not be continued beyond 24 hours. Several randomized studies have also shown a decreased risk of thromboembolism with enoxaparin prophylaxis.<sup>(19)</sup>

### **Decision-making, anatomy, and key steps in the operations:** <sup>(25,26)</sup>

#### **Positioning**

The patient is placed in the dorsal decubitus position, under general anesthesia with tracheal intubation. The legs are positioned at 30 degrees flexion, the arms along the body and buttocks slightly exceeding the operating table (Figure 1). The bladder is probed.



**Fig. (1):** Positioning of the patient for hysterectomy.<sup>(8,27)</sup>

The surgeon is positioned to the left of the patient, the first assistant to the right and the second assistant is responsible for the uterine manipulator.

### **Uterine cannulation**

Uterine cannulation is performed with a specific instrument: the uterine manipulator. The cervix is visualized via speculum and dilated to Hegar number 9. The tip of the manipulator is then inserted into the cervix under direct vision. The size of the tip to be used varies with the size of the uterus.

### **Positioning of trocars**

Four trocars are placed:

- One 10mm umbilical trocar.
- Three 5mm trocars: one 2cm medial to the right anterior superior iliac spine, another 2cm medial to the left anterior superior iliac spine, and a third in the midline, 8 to 10cm below the umbilicus (Figure 2). The latter 5mm trocar can be replaced by a 10 or 12mm trocar during surgery for the introduction of needles to suture the vaginal vault. In cases of bulkier uteri, the trocars can be positioned more cranially.

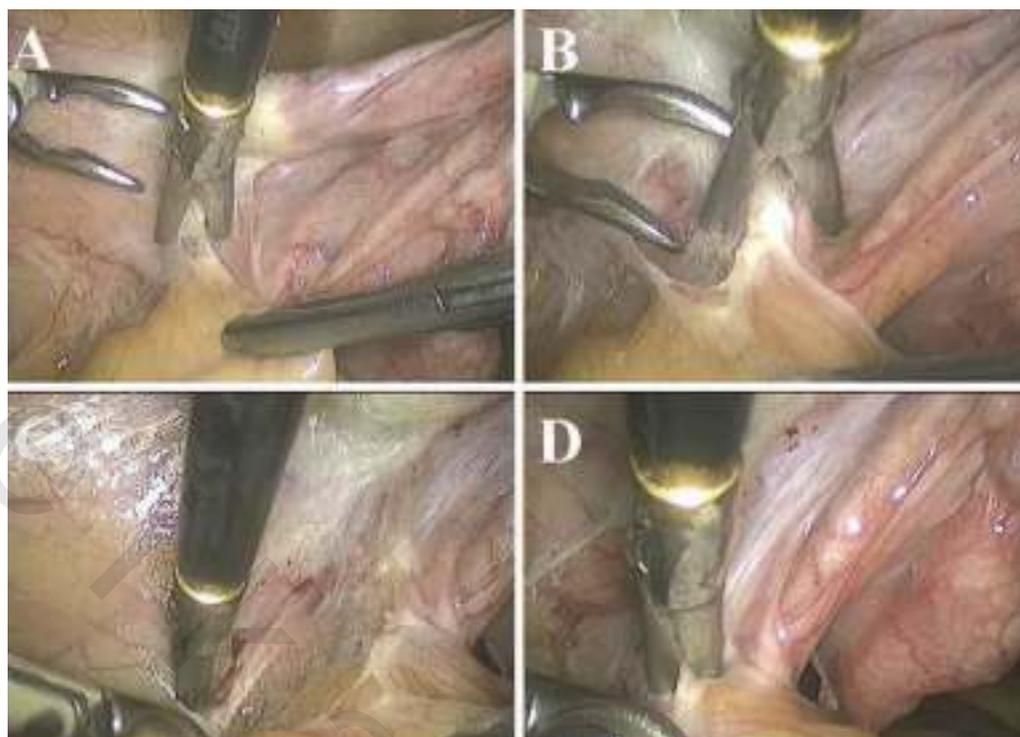


**Fig. (2):** Positioning of trocars for laparoscopic hysterectomy.<sup>(8,27)</sup>

After placing the first trocar, the patient is placed in Trendelenburg position. The small bowel is retracted in cranial direction until the sacral promontory and pouch of Douglas are clearly visible. The surgeon uses a bipolar cautery in the left hand and scissors in the right hand. The first assistant manipulates the zero degree laparoscope with the left hand and uses an Allis forceps or a grasper in the right hand.

### **Presentation of round ligaments**

The uterus is mobilized by the second assistant and maintained in a cranial and anterior position. The round ligament is then grasped and pulled by the first assistant, which facilitates surgical access to the opposite side and thus the beginning of the surgery (Figure 3).



**Fig. (3):** (A and B) Uterine manipulation using the uterine manipulator,exposing the left round ligament. (C) The first assistant pulls the left round ligament and the surgeon starts the coagulation with bipolar cautery. (D) Coagulation and section of the round ligament with laparoscopic scissors.<sup>(8,27)</sup>

### **Coagulation and division of the round ligaments**

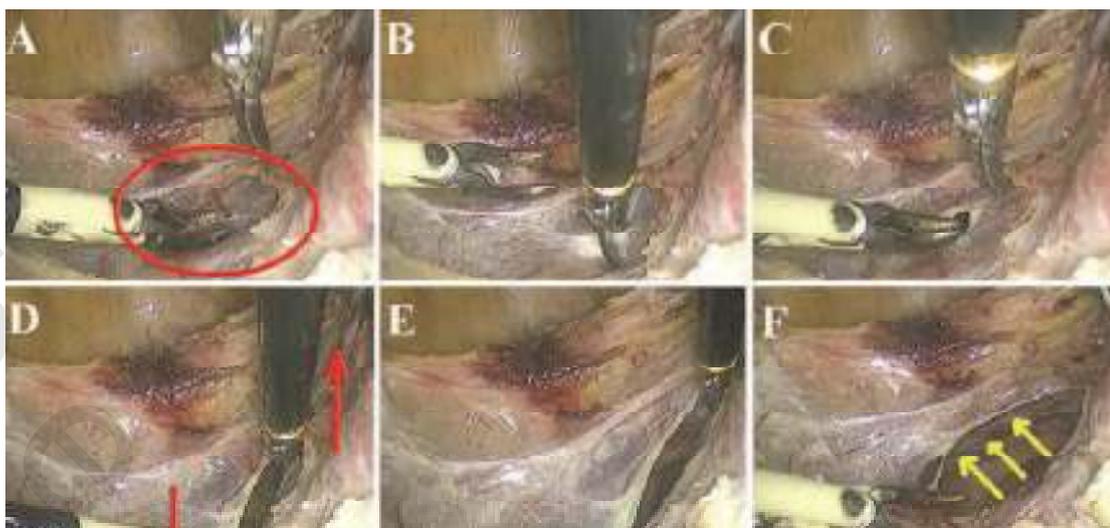
The round ligament is held about 2 to 3cm medial to lateral pelvic sidewall. It is then coagulated using bipolar cautery and the transection is performed with laparoscopic scissors (Figure 3).

### **Opening the anterior fold of the broad ligament up to the peritoneal vesicouterine fold**

The uterus is maintained in a horizontal orientation by the second assistant. The anterior leaf of the broad ligament is coagulated with bipolar forceps and sectioned, from the round ligament up to the vesicouterine peritoneal reflection.

### **Fenestration of the broad ligament**

The capillaries of the posterior leaf of the broad ligament are coagulated. The blue-gray appearance of the peritoneal leaf indicates that there are no underlying structures which can be inadvertently damaged. The posterior leaf of the broad ligament is cut and the opening is enlarged using divergent traction between the bipolar forceps and scissors (Figure 4). The ureter is then displaced laterally and inferiorly along with the peritoneum where it is less susceptible to injury.

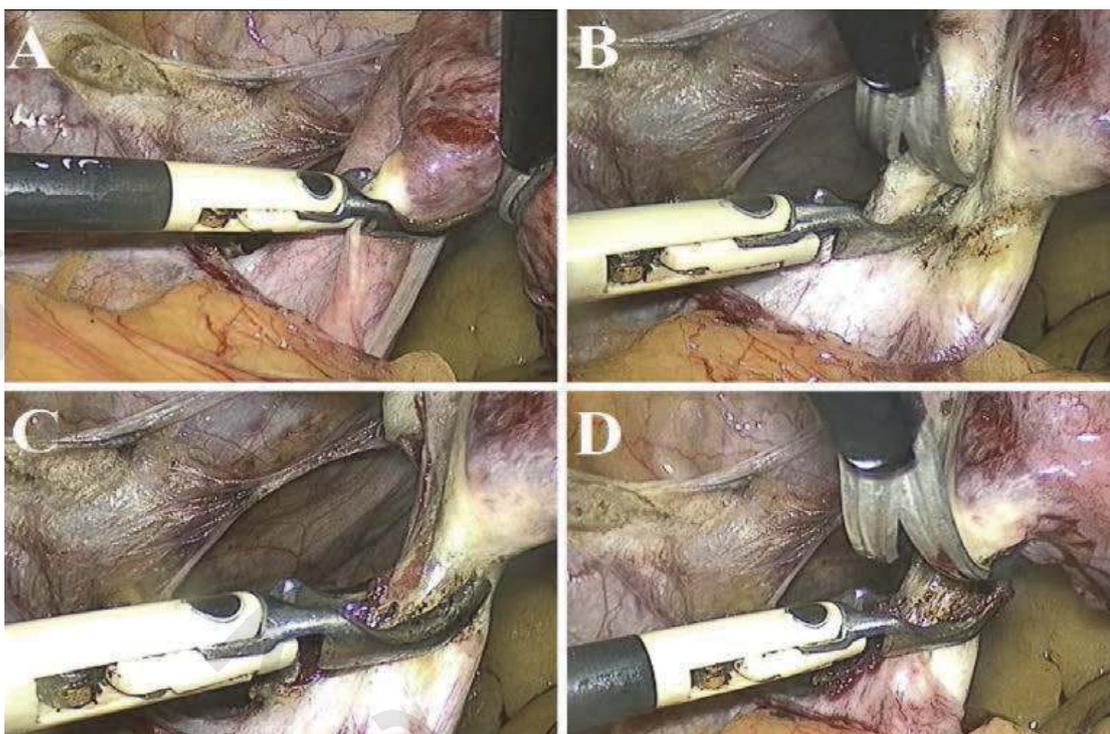


**Fig. (4):** (A) Coagulation of the capillaries of the posterior leaf of the broad ligament (red circle). (B and C) Opening of the blue region of the posterior leaf of the left broad ligament. (D and E) Fenestration of the broad ligament and the anteroposterior divergent pull of two instruments (scissors and bipolar forceps). (F) The ureter stays laterally along the left pelvic sidewall (yellow arrows).<sup>(8,27)</sup>

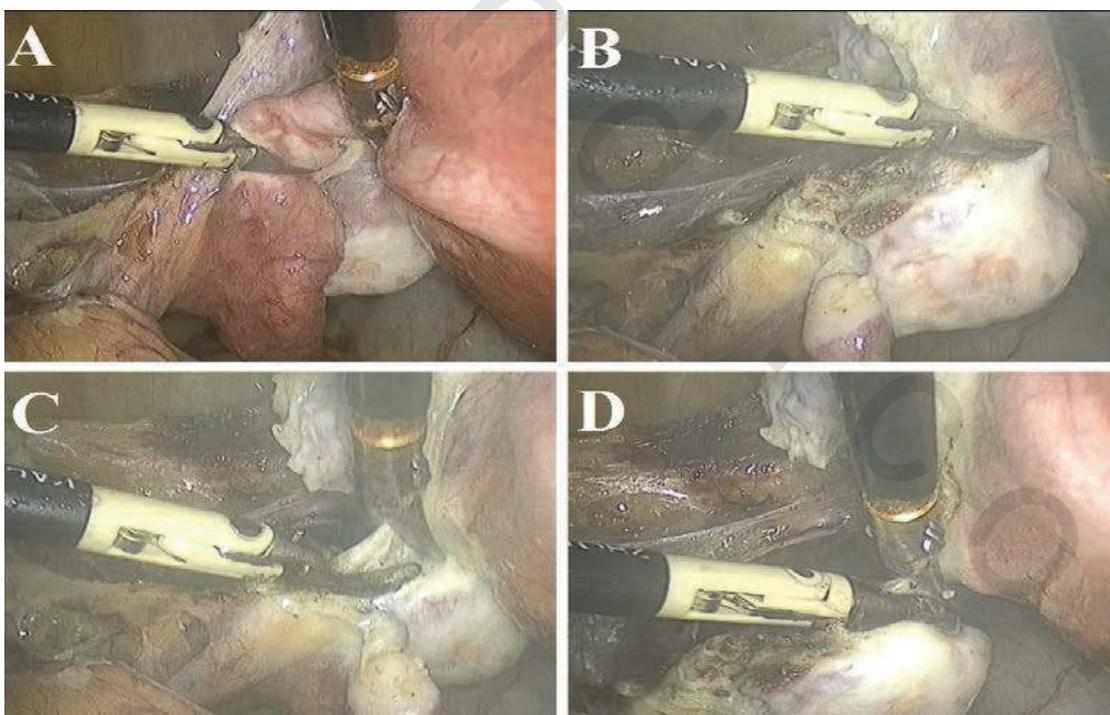
**Coagulation and section of the infundibulopelvic ligament (total hysterectomy with bilateral adnexectomy) or the utero-ovarian ligament and the tube (interadnexal hysterectomy)**

The first assistant should grasp the round ligament pedicle and apply traction towards the contralateral side of the infundibulopelvic ligament. The coagulation-section of the ligament should be progressive, plane by plane (peritoneum, followed by the vessels and the connective tissue) (Figure 5).

When ovarian conservation is desired, the coagulation-section is performed on the tube and the utero-ovarian ligament (Figure 6).



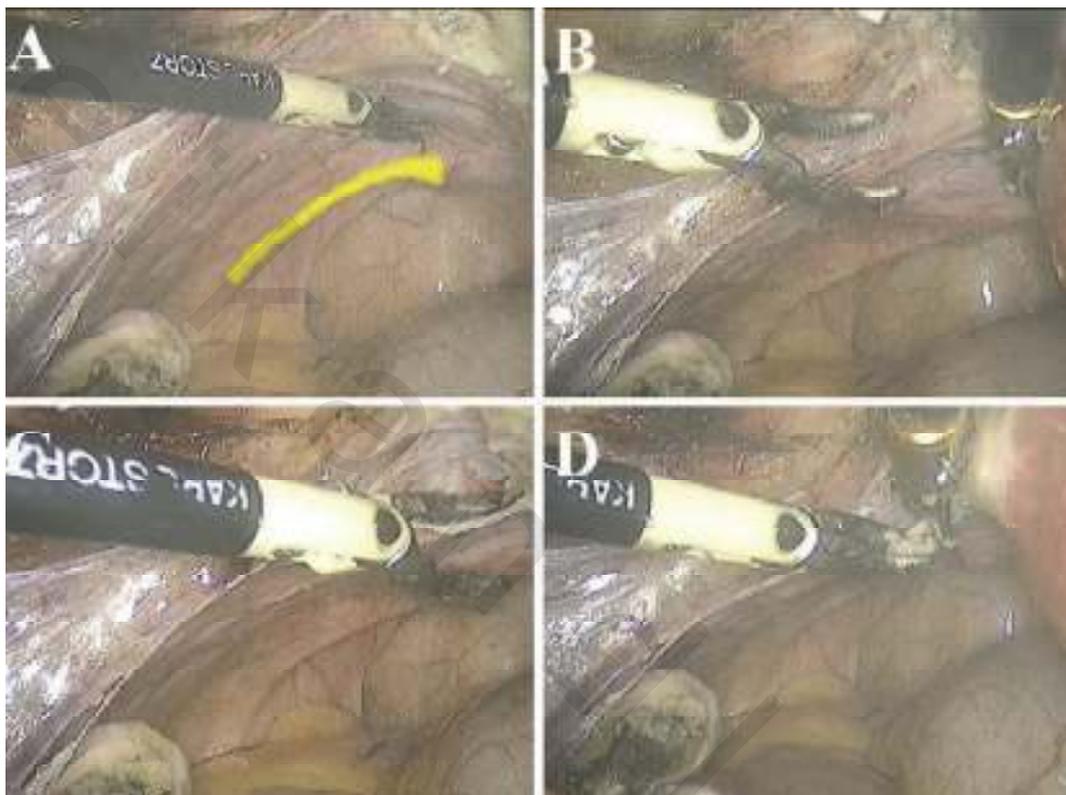
**Fig. (5):** Traction of the left adnexa by the assistant, followed by progressive bipolar coagulation of the infundibulopelvic ligament.<sup>(8,27)</sup>



**Fig. (6):** Coagulation and section of the left fallopian tube and utero-ovarian ligament in case of left adnexal preservation.<sup>(8,27)</sup>

## **Opening the posterior leaf of the broad ligament up to the uterosacral ligament**

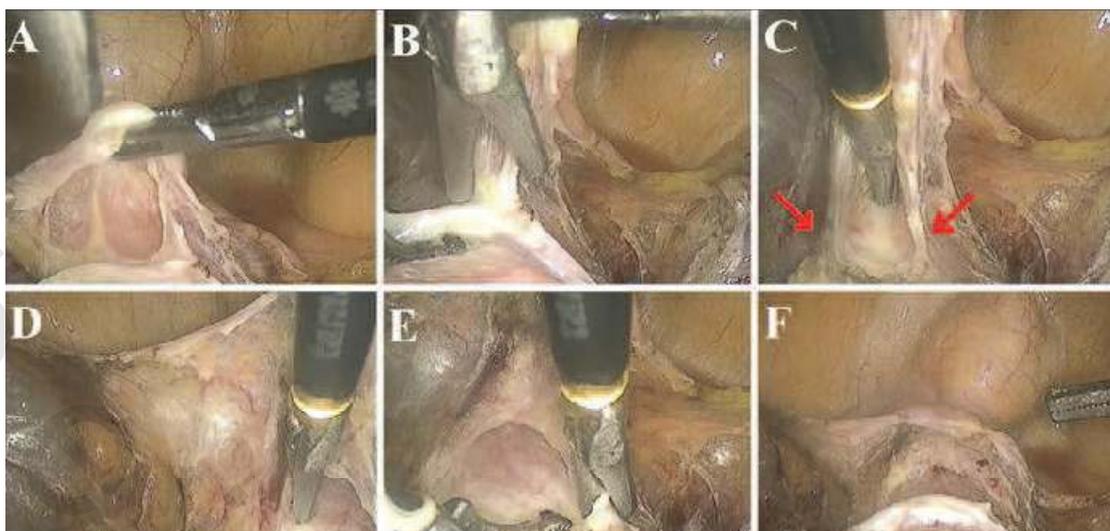
The dissection continues on the posterior peritoneum of the broad ligament, avoiding inadvertent injury of the uterine vessels (Figure 7). The peritoneum is stretched and dissected, coagulated and cut toward the uterosacral ligaments. Thus the uterine pedicle is isolated. All steps, from the coagulation-section of the round ligaments to the opening of the posterior leaf of the broad ligament, are performed in the same way on both sides.



**Fig. (7):** Opening of the posterior leaf of the broad ligament up to the uterosacral ligament (in yellow).<sup>(8,27)</sup>

## **Opening of the vesicovaginal space**

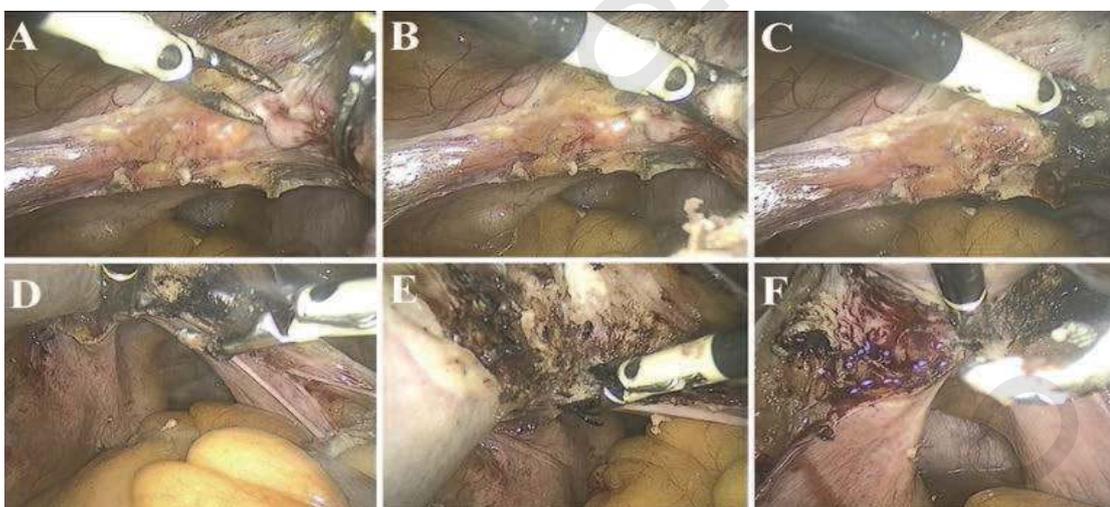
The uterus should be mobilized cranially and slightly posterior, to expose the base of the vesicouterine space. The assistant uses an atraumatic forceps to grasp the peritoneum and bladder in the midline, applying cranial and superior traction. The peritoneum and the adjacent connective tissue are coagulated and sectioned, thus accessing the vesicovaginal plane. The dissection continues in the caudal direction, initially in the midline and then laterally. Coagulation-section of the vesico-uterine ligaments is performed (Figure 8). The second assistant advances the uterine manipulator valve into the vaginal fornix to reveal the plane and facilitate dissection.



**Fig. (8):** Dissection of the vesicovaginal space. The green arrows indicate the area to be coagulated (vesico-uterine ligaments).<sup>(8,27)</sup>

### **Coagulation and section of the uterine pedicles**

The uterus is again directed cranially and laterally by the second assistant. The first assistant pulls the adnexa or the round ligament cranially and laterally. The pedicles must be very well isolated to allow an effective bipolar coagulation. The coagulation-section of the uterine pedicles, performed at the ascending uterine artery, should be carried in a progressive manner. The bipolar forceps is introduced by the lateral trocar, on the same side of the pedicle to be coagulated (Figure 9).



**Fig. (9):** (A to C) Progressive coagulation of the left uterine vessels using bipolar forceps. (D to F) Intra-fascial plane on right side.<sup>(8,27)</sup>

## **Removal of the uterus**

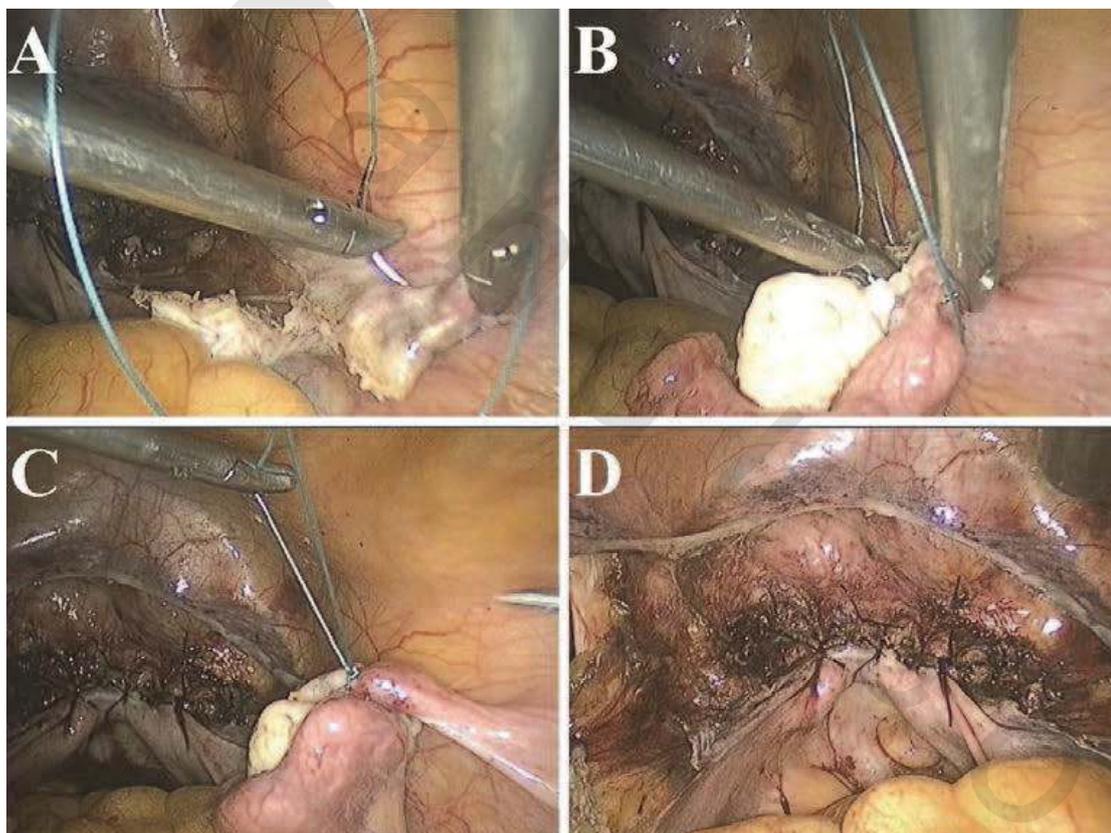
The removal of the uterus by the monopolar wire loop.<sup>(8,27)</sup>

## **Surgical extraction of the uterine specimen**

The extraction is performed by morcellating the uterus which can be performed laparoscopically, by cold knife or electric morcellator. Another method of the uterus extraction is via mini laparotomy.<sup>(8,27)</sup>

## **Adnexal pexy**

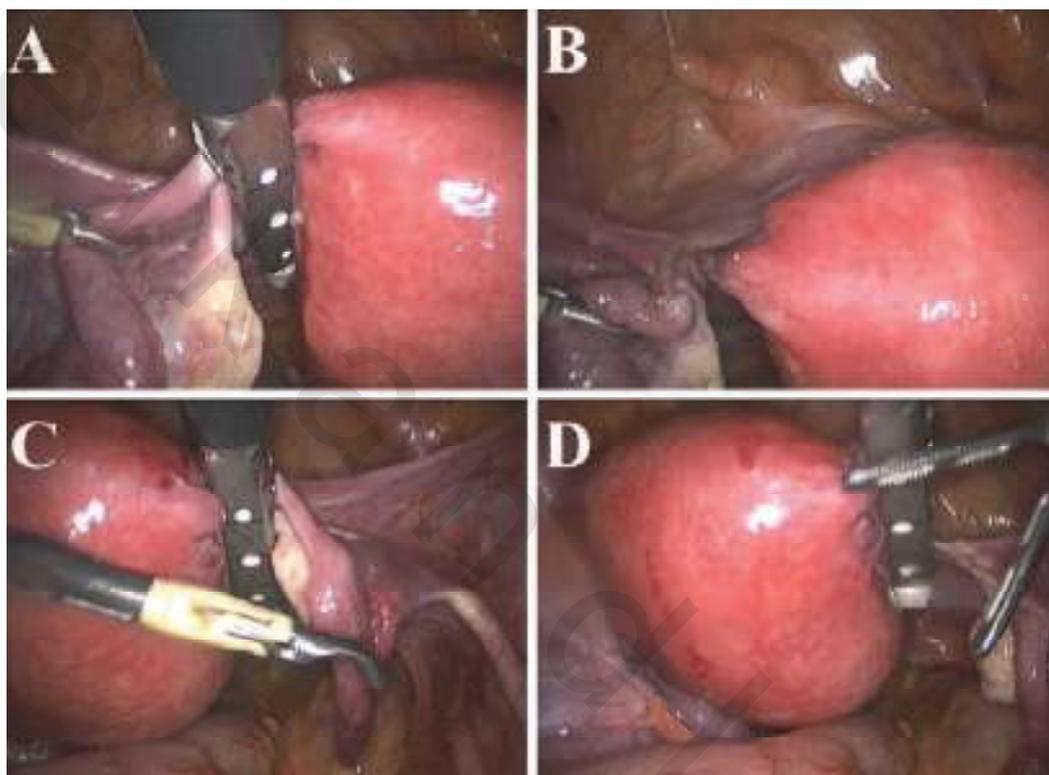
In cases of laparoscopic interadnexal hysterectomy we perform the adnexal pexy (fixation of the ovary and tube to the ipsilateral round ligament) using 2-0 polyester (Ethibond®, Ethicon Inc), to avoid adnexal torsion in the postoperative course (Figure 10). Hemostasis is checked (Figure 10). The fascial defect of the 10mm trocar in the midline is sutured. The pneumoperitoneum is deflated and the skin is sutured with 3-0 monofilament absorbable suture (Poliglecaprone 25, Monocryl®, Ethicon Inc).



**Fig. (10):** (A to C) Fixation of the ovary to the round ligament on the right side using 2-0 Ethibond®. (D) Final appearance of the vaginal vault after homeostasis.<sup>(8,27)</sup>

### **Alternative techniques to the use of bipolar energy**

There are some technical alternatives to the use of bipolar energy for laparoscopic hysterectomy. Bipolar energy seems to be a safe cost-effective method with good control and accuracy during dissection and sectioning of the uterine vessels and other structures. However, the use of disposable laparoscopic instruments can afford the surgeon a slightly shorter surgical time. Options include endoscopic linear cutting staplers (Figure 11), the LigaSure® Vessel Sealing system (Valleylab) (Figure 12), the EnSeal® tissue sealing system (Advanced Tissue Sealing Technology) (Figure 13), and the Ultracision® harmonic scalpel (Figure 14).



**Fig. (11):** Use of endoscopic linear cutting staplers for total laparoscopic hysterectomy. <sup>(8,27)</sup>



**Fig. (12):** Use of the LigaSure® Vessel Sealing for control of the infundibulopelvic ligament in total laparoscopic hysterectomy. <sup>(8,27)</sup>

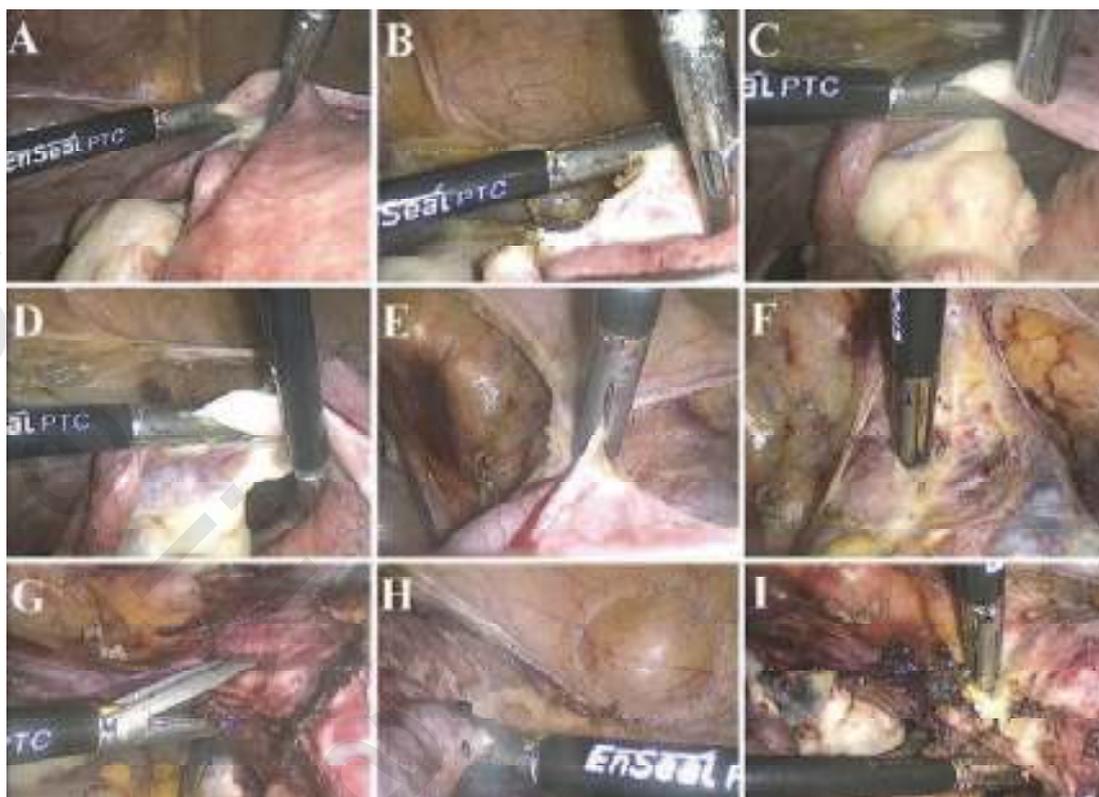


Fig. (13): Use of EnSeal® during total laparoscopic hysterectomy. (8,27)

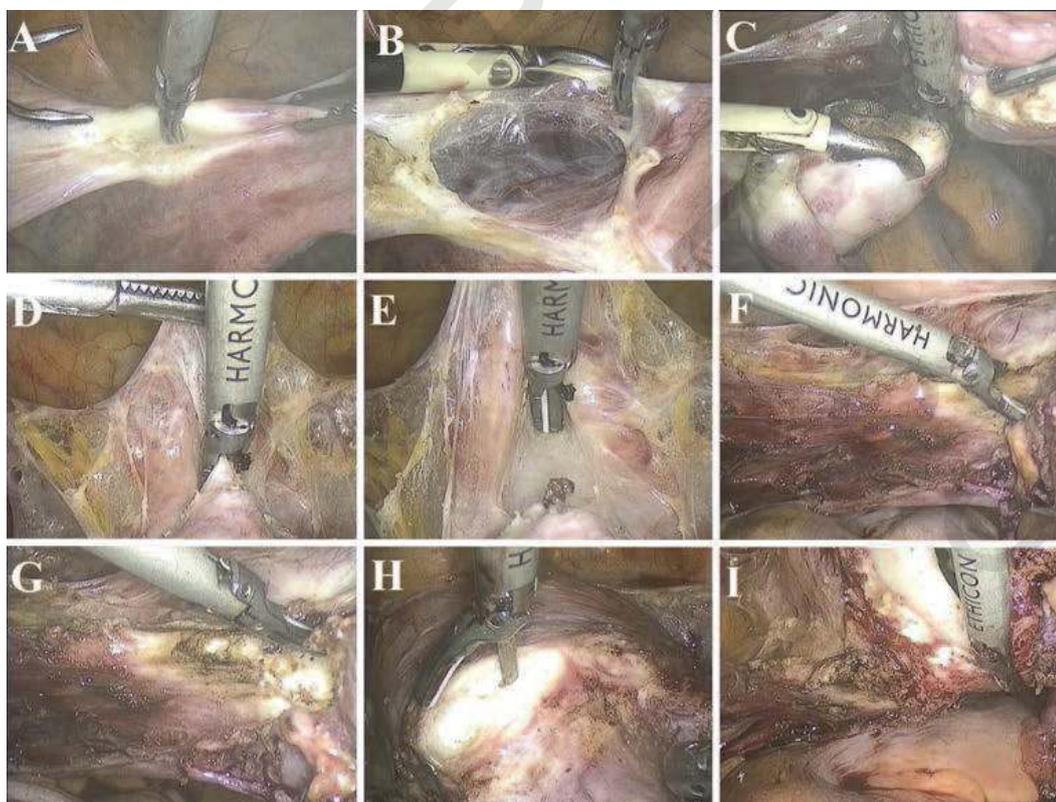


Fig. (14): Use of Ultracision® harmonic scalpel in total laparoscopic hysterectomy. (8,27)

### **Salpingectomy / bilateral oophorectomy**

The bilateral oophorectomy at the time of hysterectomy for benign disease is commonly performed in order to prevent the subsequent development of ovarian cancer or ovarian pathology that may require additional surgery. Currently, bilateral oophorectomy is performed in 78% of women aged between 45 and 64 years who undergo hysterectomy, and a total of 300,000 prophylactic oophorectomies are performed in the United States each year. Estrogen deficiency resulting from oophorectomy in pre- and postmenopause has been associated with increased risk of coronary heart disease, stroke, hip fracture, parkinsonism, dementia, cognitive impairment, depression and anxiety. In general, removal of the ovaries at the time of hysterectomy should be carefully evaluated in women who are not in the high risk group for developing breast cancer or ovarian cancer.<sup>(28,30)</sup>

Repasy et al. (2009) evaluated the impact of removal of the tubes at the time of hysterectomy on ovarian survival, noting that 35.5% of patients in whom the fallopian tubes were intact developed hydrosalpinx. However, there was cystic degeneration of orphan ovaries (absence of the Fallopian tube) earlier than in the group with preservation of the tube (50 vs.84.2 months;  $p=0.031$ ). So removal of the tube during hysterectomy decreases the incidence of development of pelvic masses in the future, but it causes earlier cystic degeneration in remaining ovaries.<sup>(31)</sup>

### **Postoperative care**

The patient is given a regular diet 6 hours after the procedure. If the postoperative course is uneventful, patients can be discharged on the first postoperative day. They must be advised to avoid vaginal intercourse for 40 days. Postoperative consultations are performed within 7 days to remove the dressings and 40 days to evaluate the healing of the vaginal vault.

### **Complications**

A hysterectomy is a safe procedure with a low mortality rate, estimated at 0.12 to 0.34 per 1000 surgeries. Complications directly related to the laparoscopic approach include those related to the positioning of the Verrees needle and trocars (bleeding, bowel injury), those related to pneumoperitoneum insufflation, hernia at the fascial defect created by the trocar and need to convert to open surgery. Other complications are related to the surgical procedure itself and are basically the same, regardless of the approach used for the hysterectomy, such as bleeding, urinary and bowel injuries, anesthetic problems, pulmonary thromboembolism, postoperative infection (urinary, pulmonary, surgical), problems in the vagina (hematoma, abscess and dehiscence), etc.<sup>(19)</sup>

At late nineties; hysterectomy complication were analyzed, including abdominal, vaginal and laparoscopic, noting an overall rate of complications (including major and minor) of 17.2%, 23.3% and 19%, respectively. Lesions of the ureter occurred predominantly in the laparoscopic group (0.2%, 0% and 1.1% respectively), whereas the intestinal lesions were more frequent in the vaginal group (0.2%, 0.5% 0.4%, respectively). The intra-operative bleeding requiring surgical intervention or blood transfusion during surgery was more common with vaginal hysterectomy (3.1% compared with 2.1% in abdominal hysterectomy). Infections (wound, intra-abdominal, vaginal, urinary tract, fever of unknown origin, etc.) were the most frequent complications, with an incidence of

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10.5%, 13% and 9% in the abdominal, vaginal and laparoscopic hysterectomy groups, respectively.<sup>(32)</sup>

The recent series of Donnez et al. showed no increased rates of major complications when laparoscopic hysterectomy is performed by experienced surgeons. There was no difference in the rate of ureteral injury after vaginal (0.33%) and laparoscopic hysterectomy (0.25%). Bladder injuries occurred in 0.44% of women undergoing vaginal hysterectomy and 0.31% in those undergoing laparoscopic hysterectomy.<sup>(8)</sup>

Another reported complication after laparoscopic hysterectomy is adnexal torsion. The prevalence of this complication was 7.91 per 1,000 cases and occurred approximately 2.64 years after laparoscopic hysterectomy. To avoid this complication, we perform adnexal fixation (ovary and fallopian tube to the round ligament) at the time of laparoscopic hysterectomy is advanced.<sup>(33)</sup>

### **Conversion**

Risk factors for conversion in laparoscopic surgery include body mass index, history of previous laparotomy, suspected malignancy, presence of adhesions, technical difficulties, complex cases, surgeon experience and uterine weight.<sup>(34)</sup>

### **Learning curve**

Observational and retrospective studies have shown a lower rate of complications and conversion to laparotomy with increasing surgeon experience, thus demonstrating a learning curve for the procedure. In a study, surgeons who performed more than 30 laparoscopic hysterectomies had lower rates of complications of the ureter, bladder and bowel compared with less experienced colleagues. Another one showed that after the initial experience of 30 cases the surgical time of laparoscopic supracervical hysterectomy decreased significantly. Another one observed a significant reduction in surgical time (from 201.4 minutes to 137.2 minutes,  $p < 0.001$ ) comparing the first 2 cases and the last two cases of laparoscopic supracervical hysterectomy performed by senior residents.<sup>(7,35,36)</sup>