Laparoscopic lymph node dissection using ultrasonically activated shears: comparison with electrosurgery

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Purpose
The aim was to assess and compare perioperative parameters in two groups of patients treated by different laparoscopic techniques of lymph node dissection (LND) for gynecologic cancer.

Patients and methods
Between October 2015 and October 2017, 59 consecutive women with microinvasive cervical cancer ($N=5$) or clinical stage I endometrial cancer ($N=54$) underwent laparoscopic LND during a primary staging procedure using an electrosurgery (ELC) or ultrasonic (US) operative technique. The two groups were compared for perioperative outcomes. Differences between the two groups were determined by the Wilcoxon's rank-sum test.

Results
Laparoscopic LND and other staging procedures were completed successfully in 58 (98.3%) women. There were no statistically significant differences between the groups regarding preoperative outcomes (operation time, time for LND, blood loss, hospital stay, and complications), but there was a significant difference ($P=0.0008$) in the number of lymph nodes harvested: a mean of 13.7 in the ELC group and 17.5 in the US group. The pathologists found that the reading of histology slides was easier after US dissections because of the greater depth of thermal injury in the lymphatic tissue in ELC group.

Conclusion
The US operative technique ensures efficient coagulation, cutting, dissection, and grasping for laparoscopic LND in patients with cervical and endometrial cancer.

Keywords:
cervical cancer, harmonic dissection, laparoscopic,

Introduction

The most recent publications indicate that there is growing interest in operative laparoscopy in gynecologic oncology [1]. One of the cornerstones of uterine cancer surgery is the assessment and removal of the regional lymph nodes. Laparoscopic pelvic lymphadenectomy was first described by Dargent and Salvat in 1989 [2], and Querleu et al. [3] published their experience in 1991. Hemostasis during laparoscopic surgery is typically achieved with electrosurgery (ELC). Shen et al. [4] used ultrasonically (US) activated coagulating shears in two patients who underwent laparoscopic paraaortic lymphadenectomy for cervical cancer. Holub and colleagues [5,6] successfully performed complete laparoscopic surgical staging using US instruments in a smaller group of patients with endometrial cancer. They believe that this operative technique and instrument works as effectively as monopolar electrocautery and have the theoretical benefits of avoiding potential electrical injury to adjacent abdominal and pelvic structures. The purpose of this study was to determine if US energy can replace ELC in laparoscopic lymph node dissection (LND) in a large group of patients with endometrial or cervical cancer.

Patients and methods
Patients

A total of 59 women were treated with either ELC ($N=32$) or US ($N=27$) with laparoscopic LND and other procedures carried out for cervical or endometrial cancer from October 2015 to October 2017 at Surgical Department Menoufia University. The protocol of this research has been reviewed by our research ethics committee in the faculty of Medicine, Menoufia University. Five patients experienced microinvasive cervical cancer Federation International of Gynecology and Obstetrics stage A1 or A2, and 54 patients had grade 2 or 3 endometrial cancers or deeply infiltrating grade 1 endometrial cancers. The

women underwent laparoscopically assisted vaginal hysterectomy (LAVH), bilateral salpingo-oophorectomy, and laparoscopic lymphadenectomy. Preoperative records were sorted into two groups: ELC and US surgery (Table 1). The patients with clinical stage I carcinoma of the endometrium and microinvasive cervical cancer underwent preoperative history and cervical or endometrial biopsy, with ultrasonography and computed tomography scanning or MRI. We monitored the following parameters: duration of surgery (time needed for dissection of the pedicle and excision of lymph nodes), blood loss, histologic and pathologic findings, number of excised lymph nodes, preoperative and postoperative complications, hospital stay, and the patients' age and weight. There were no significant differences regarding age, weight, or previous pelvic surgery (Table 1).

Operative technique

Laparoscopy was performed using video monitoring equipment with the patient in the lithotomy position. The telescope was inserted supraumbilically, and one 10-mm port was placed hand fest adjacent to telescope port. Two or three 5-mm ports were placed in each of the lower quadrants at the lateral edge of the rectus abdominis muscle. In the ELC group, after the diagnostic laparoscopy, bipolar and monopolar electrocautery devices (Karl Storz Endoscope; Karl Storz, Tuttlingen, Germany) were used. In the US group, the shears [laparoscopic coagulating shear (LCS)-K5 or LCS-C] (Ultracision Ethicon Endosurgery; Johnson & Johnson Ltd, Cincinnati, Ohio, USA) were applied at power levels from 1 to 5 (full power). Lower power levels allowed better coagulation but slower cutting. Higher power levels allowed faster transection of relatively avascular tissue. The round ligaments and infundibulopelvic or utero-ovarian ligaments were coagulated by bipolar forceps or US shears, being incised then by monopolar dissector or US shears, respectively. The origin of the uterine artery was desiccated from the hypogastric artery and afterward dissected by monopolar or US shears. Lymph node-bearing adipose tissue was excised from the pelvic and low paraaortic space using monopolar or US shears. Only 5-mm instruments were used in both groups. Laparoscopically assisted surgical staging required a complete inspection of the entire peritoneal cavity. Intraperitoneal fluid was aspirated from each of the four quadrants and examined cytologically. Second-look laparoscopy was then performed to secure or confirm hemostasis in cases of LAVH. An intraperitoneal drain was introduced and left in place. All patients received deep venous thrombosis prophylaxis in the form of low-molecular-weight heparin and were given prophylactic antibiotics during the operation.

Laparoscopic lymph node dissection

Transperitoneal pelvic lymph node dissection and infra-aortic lymph node sampling

Dissection was begun by incising the peritoneum over the right common iliac artery and extending this incision caudally along the external iliac artery toward the round and broad ligaments. Lymph node tissue was excised from the obturator fossa after mobilization of the external and internal iliac vessels and the obturator nerve. We dissected the lymph nodes up to the level of the bifurcation of the iliac vessels according to the classification of Querleu *et al.* [7]. After incision of the peritoneum overlying the right common iliac artery, infra-aortic lymph node sampling was initiated after extending the incision cranially along the aorta up to the level of the inferior mesenteric artery. Our technique of LAVH (with vaginal or laparoscopic colostomy) and bilateral salpingo-oophorectomy is described elsewhere [8]. US-activated shears were used in the US group and bipolar (Figs 1 and 2) and monopolar diathermy in the

Figure 1

Dissection over external iliac vein using harmonic shear.

Figure 2

Dissection of paraaortic nodes using electrosurgery.

Table 1 Characteristics of women and type of surgery

	Electrosurgery	Ultrasonic	*P* value
N	32	27	
Age (years)	55.6 (30–76)	57.1 (41–79)	NS
Weight (kg)	78.3 (58–121)	83.8 (65–115)	NS
Previous surgery	8 (25)	8 (29.6)	NS
Type of surgery			
LAVH, BSO, and PLN	30	23	
LAVH, BSO, and ILNS	2	3	
PLN	0	1	

BSO, bilateral salpingo-oophorectomy; LAVH, laparoscopic-assisted vaginal hysterectomy; PLN, pelvic lymphadenectomy; ILNS, infra-aortic lymph node sampling.

Table 2 Outcomes of surgery and recovery

	Electrosurgery	Ultrasonic	*P* value
Total operating time (min)	148.2 (120–180)	155.1 (120–185)	NS
Time to bilateral PLN	63.6 (50–72)	59.8 (50–70)	NS
Total blood loss (ml)	210.2 (80–700)	194.2 (50–800)	NS
Estimated blood loss to PLN	65 (20–100)	80 (50–100)	NS
Number of lymph nodes	13.7 (4–21)	17.5 (8–36)	0.0008
Hospital stay (days)	4.2 (2–0)	3.6 (2–7)	NS
Complications	1	0	
Injury to epigastric artery	1	1	
Fever	1	1	
Transfusion	0	1	
Inflammation of the obturator nerve	0	1	
Intraoperative cardiac dysrhythmia conversion to laparotomy	1	0	

PLN, pelvic lymphadenectomy.

ELC group. The routine surgical procedure was used during the vaginal phase.

Statistical methods

We evaluated and compared differences in the preoperative and postoperative outcomes of the two groups of patients with different laparoscopic surgery techniques of LND in cervical and endometrial cancer: the ELC group and the US group. Differences between the two groups were determined by the Wilcoxon's rank-sum test by an independent biometrician. *P* values less than 0.05 were considered significant.

Results

Laparoscopic LND and other procedures were completed successfully in 58 of the 59 women (98.3%). We converted to laparotomy in one patient with endometrial cancer in a myomatous uterus from the ELC group, who had extensive intra-abdominal adhesions and uncontrolled bleeding from a trocar injury of the epigastric artery. The outcomes of surgery and recovery are summarized in Table 2. The mean time required to open and clear the bilateral pelvic lymph node spaces was 63.6 min in ELC group and 59.8 min in the US group (*P*=5;

NS) (Table 2). Lymph node sampling in the low paraaortic spaces prolonged the time of operation by 30 min on average, regardless of the operative technique used. In the laparoscopic group, simultaneous low paraaortic lymph node sampling prevailed, but the difference in surgery duration in the two groups (63.6 vs. 59.8 min) was statistically insignificant.

An overview of the complications is shown in Table 2. We were unable to perform prompt and thorough hemostasis in one obese (105 kg) patient from the US group because of ineffective post-US coagulation of venous varices on the venous ovarica, which were retracted into the subperitoneal fat. However, bipolar coagulation was effective in this case. There were no major complications necessitating the patient's return to the operating room. In connection with the difficult extirpation of fibrotic lymph nodes in the obturator fossa, signs of inflammation and edema of the obturator nerve have appeared postoperatively in one US-treated patient, which subsided after anti-inflammatory and electrostimulative convalescence therapy.

The US shears were effective in all cases of LND. Blood loss was minimal, and only two transfusion units

Table 3 Surgical stage

	Electrosurgery	Ultrasonic
Endometrial cancer		
Ia: no myometrial invasion	5	5
Ib: myometrial invasion to 50%	5	14
Ic: myometrial invasion to 50%	10	8
IIIa	1	0
IIIc	2	2
Lymph node positive	2	2
Pelvic lymph node positive	2	2
Infra-aortic lymph node positive	0	0
Ia 1	2	2
Ia 2	0	1
Lymph node positive	0	0

were required in the two patients with intraoperative and postoperative bleeding (Table 2). The estimated blood loss during the LND phase was similar in the two groups (65 and 80 ml in the ELC and US groups, respectively) without any significant subsequent changes in the values of hemoglobin.

The frequency of poorly differentiated lesions (grade 2 or 3) and lesions invasive to 50% of myometrium in endometrial cancer was similar in the two groups. Five patients with positive washings or microscopically positive lymph nodes had stage III disease (Table 3). The mean number of lymph nodes excised was 13.7 in the ELC group and 17.5 in the US group. There was a significant difference ($P < 0.0008$) in the lymph node yield. The pathologists found that the reading of histology slides was easier after US dissections because of the greater depth of thermal injury in the lymphatic tissue in the ELC group.

Discussion

Traditionally, laparoscopic surgical treatment of uterine cancer has been performed electrosurgically [1,7]. Bipolar cautery is probably the most commonly used technique for hemostasis in ovarian vessels in the infundibulopelvic ligament, the tube and utero-ovarian ligament, and the round ligament. Jones [9] suggests that one technical problem is that you must exchange the bipolar coagulator for scissors to cut the tissue after it has been coagulated. The Harmonic Scalpel (Ethicon Endosurgery; Johnson & Johnson) enables a surgeon to carry out both coagulation and vessel division with the same instrument. Amaral [10] first described the development of this ultrasonically activated scalpel in 1994. US surgery is based on mechanical vibration of a metal tip. The vibrations selectively break down and remove tissue with high water content and spare tissue with high collagen content such as blood

vessels, nerves, and ductal structures. The advantages of US dissection include less thermal damage to the surrounding tissues and less smoke [10].

Recently, the US scalpel was introduced into laparoscopic oncologic surgery by several groups [4,5,11–13].

This scalpel has the capacity to cut and coagulate tissue simultaneously without electrical current.

Numerous technologic and surgical advances have led to the application of operative laparoscopic techniques in the management of gynecologic cancer [14]. Adequate evidence supports the idea that transperitoneal extirpation of pelvic and aortic lymph nodes by laparoscopy can be performed safely, is associated with minimal morbidity and short hospitalization, and provides valuable information about the status of the lymph nodes without missing nodal metastases [15–19]. Operative laparoscopy has been described in the surgical staging and treatment of patients with cervical, endometrial, and ovarian cancer [1]. The removal of the regional lymph nodes is an important part of surgical staging of these patients. In a recent literature review (MEDLINE), we found only a few reports of the application of the Harmonic Scalpel or LCS in laparoscopic LNDs [4–6,11].

The results of our study showed that ELC and US techniques were similar in terms of preoperative outcomes. We are aware of findings by Shen *et al.* [4] and Amaral [10] in which the Harmonic Scalpel or LCS provided both hemostasis and cutting with decreased charring of tissues and less thermal damage. Hemostasis with the US-activated shears was less effective (successful procedure rate 96.2%) than ELC in only one case of venous bleeding in an obese patient. It is possible that the less efficient hemostasis ability of US shears reflects the different mechanism of tissue fat coagulation in comparison with ELC. Laser and electrical energy denature tissue proteins through production of heat, whereas US energy does it mechanically. No significant difference in surgery duration, type of surgery, blood loss, hospital stay, histologic and pathological findings, or complications was found. We confirmed malignant changes in the lymph nodes or peritoneal cytology specimen or both in five women. Spread outside the regional lymph nodes was found in 6.7% of the patients, which corresponds with figures in the literature [20]. Compared with ELC, the US shears were advantageous in taking a larger number of lymph nodes, and the difference was statistically significant

(P<0.0008). We think that the difference was influenced by an increase in experience with laparoscopic LND, but also by the fact that the surgeon was not blinded to the tool being used. In 1996, after the laparoscopic technique had been introduced, we removed an average of nine regional lymph nodes from the pelvic area in patients with endometrial cancer [21]. However, the difference could have been influenced by a more radical attitude enabled by the US technique. We performed LCS dissections of lymph nodes with minimum bleeding very close to the major pelvic vessels and ureter. The safe removal of the lymphatic tissue from the obturator fossa was made possible by coagulation and dissection of aberrant and penetrating veins close to the iliac vein.

Laparoscopic lymph node dissection

Irritation and subsequent inflammation of the obturator nerve in one laparoscopically treated patient is a warning against indelicate coagulation and dissection in the obturator fossa region. During preparation and dissection of lymph nodes close to the obturator nerve, laparoscopic instruments should be used with increased caution, and coagulation should not be used closer than 2 mm to the nerve wall.

At present, published observations regarding ultrasound-induced complications are rather scarce and are based on several case reports. Awwad and Isaacson [22] described an injury of the sigmoid intestine during lysis of pelvic adhesions by a Harmonic Scalpel. Stringer [23] reported a large number of surgical procedures performed with the Harmonic Scalpel. In 26 patients having second-look procedures following laparoscopic myomectomies, 65% had either no adhesions (grade 0) or grade 1 adhesions, 12% had grade 2 adhesions, and 23% had grade 3 adhesions. Additional reports of second-look data indicate that ~67% of patients develop postoperative adhesions after laparoscopic myomectomy performed with ELC [24].We appreciated the possibility of using the tip of the US shears for the separation of particular tissue and the removal of dissected lymph nodes. The disadvantage of slower coagulation speed compared with ELC was offset by the absence of a need to change the shears during the operation. Evidence for this view is that the average duration of bilateral pelvic LND procedures was 59.8 min, which is similar to the duration (63.6 min) of the same procedure performed by the ELC technique. Possover *et al.* [25] in Jena, Germany, described very similar outcomes in laparoscopic lymphadenectomy in gynecologic malignancies. In their experience, bilateral pelvic and low paraaortic lymphadenectomies require 120 min: 60 min for the bilateral pelvic lymphadenectomy and ~30 min each for the right (36 min) and left (24 min) paraaortic lymphadenectomies.

Conclusion

Our trial illustrates that an operative technique with 5-mm US-activated shears ensures efficient coagulation, cutting, dissection, and grasping in laparoscopic LND in patients with cervical and endometrial cancer. The laparosonic operative technique allows the performance of secure coagulation and dissection near important pelvic and abdominal structures such as the ureter and larger vessels in addition to the benefit of preserving the specimen with better histopathological examination.

Conflicts of interest
There are no conflict of interest.

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