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ORIGINAL ARTICLE

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Laparoscopic surgical staging for uterine malignancies using harmonic shears (UltraCision) in comparison to electrosurgery: operative technique, feasibility and complications

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Abstract This retrospective study assesses and compares perioperative parameters in two groups of patients treated by different operative techniques of laparoscopic surgical staging (LASS) for uterine cancer. Between April 1996 and May 2005, 119 consecutively selected women with cervical cancer (n=30) or clinical stage I endometrial cancer (n=89) underwent laparoscopic assisted vaginal hysterectomy (LAVH), total laparoscopic hysterectomy (TLH) or radical laparoscopic assisted vaginal hysterectomy (RALVH) plus bilateral salpingo-oophorectomy (BSO) and/or lymph node dissection (LND) during a primary surgical procedure using an electrosurgery (ELC, n=37) or ultrasonic (US, n=82) operative technique (harmonic shears, UltraCision). The UltraCision was used as a primary method of dissection and hemostasis from 1999. We were unable to perform prompt and thorough hemostasis in 2 patients from the US group (successful procedure rate 97.5%) because of ineffective post-ultrasonic coagulation of venous paravaginal varices (RALVH procedure) and of vena ovarica varices (LAVH, BSO procedure). The UltraCision was effective in all cases of lymphadenectomy. Successful procedure rate of the ELC operative technique was 100%. There were no statistically significant differences between the groups with regard to operation time, blood loss, hospital stay, and complications. There was a significant difference (P<0.001) in the number of lymph nodes harvested: a mean of 18.1 in the US group and 13.7 in the ELC group. We think that the difference was influenced by an increase in experience with laparoscopic lymph node dissection. The UltraCision operative technique ensures efficient dissection, coagulation, cutting, and grasping for LASS in women with cervical and endometrial cancer.

Keywords Endometrial cervical cancer · Cancer laparoscopy · Harmonic scalpel · Electrosurgery

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Introduction

The standard approach to the surgical management of early stage uterine cancer has been to perform the primary surgery via an open technique. Peritoneal washing is obtained for cytology, a thorough exploratory laparotomy is performed, and an extrafascial or radical hysterectomy plus bilateral salpingo-oophorectomy are carried out. Pelvic and para-aortic lymph node dissection are performed to complete surgical staging. A laparoscopic radical hysterectomy (LRH) with pelvic and aortic lymph node dissection for cervical cancer was first reported in 1992 [1]. Since the report by Childers and Surwit [2] on laparoscopically-assisted surgical staging (LASS) in endometrial cancer, several reports series of patients have followed [3–6]. Laparoscopic surgical treatment of uterine cancer has usually been carried out by electrosurgery. Laser and argon beam coagulator or stapler have also been utilized for dissection, cutting and hemostasis. There is continued emphasis on developing instruments and techniques that make these procedures practical, safe, reproducible, and cost-effective [7].

Recently, the harmonic scalpel (HSc) has been introduced in laparoscopic oncologic surgery [8–10]. HSc and laparosonic coagulating shears are other terms for ultrasonically activated instruments. The use of ultrasonic energy allows both coagulation and cutting with the same device while avoiding potential complications related to electrosurgery. Shen and associates [9] used ultrasonic instruments in 2 patients who underwent laparoscopic para-aortic lymphadenectomy for cervical

cancer. Holub et al. [10] first successfully performed LASS using ultrasonically activated coagulating shears in women with endometrial cancer.

The purpose of this study was to assess the ultrasonic operative technique, feasibility and complications in a large group of patients laparoscopically staged for endometrial or cervical cancer.

Materials and methods

A retrospective comparative clinical study was undertaken at the Department of Obstetrics and Gynecology, Baby Friendly Hospital, Kladno, which included 119 women treated either ultrasonically (n=82) or electrosurgically (n=37) with laparoscopic hysterectomy and/or regional lymphadenectomy carried out for cervical or endometrial cancer between April 1996 and May 2005. Thirty patients suffered from early cervical cancer as reported by the Federation International of Gynecology and Obstetrics (FIGO) stage A1, A2 or B1, and advanced cervical cancer stage II. Eighty-nine patients had grade 2 or 3 endometrial cancer or deeply infiltrating grade 1 endometrial cancers. Table 1 lists the basic criteria for offering a laparoscopic surgical staging. Common criteria were the following: body mass index (BMI) index less than 40, a desire for a laparoscopic approach, and signed informed consent.

Comparison was made between a cohort of 37 women who underwent LASS using electrosurgery from April 1996 to December 2000, and a cohort of 82 patients who were treated ultrasonographically only as a primary method of dissection and hemostasis from January 1999 to May 2005. The women underwent laparoscopically assisted vaginal hysterectomy (LAVH), total laparoscopic hysterectomy (TLH), laparoscopically assisted radical vaginal hysterectomy (RALVH), bilateral salpingo-oophorectomy (BSO), and/or pelvic laparoscopic lymphadenectomy (PLN). Infra-aortic lymph node sampling (ILNS) was carried out only in selected cases. Perioperative records were sorted into two groups: electrosurgery (ELC) and ultrasound surgery (US; Table 2). The patients with clinical early-stage uterine cancers and locally advanced cervical carcinoma underwent preoperative history evaluation, cervical or endometrial biopsy and hysteroscopy, with ultrasonography and CT scanning or MRI. All procedures were performed by a single surgeon (Z.H.). We monitored the following parameters: duration of surgery (time from skin incision to skin suture), blood loss, hospital stay, histology and pathologic finding, number of excised lymph nodes, and intraoperative and postoperative complications. There were no significant differences with regard to age, weight, or previous pelvic surgery (Table 2).

The study was approved by the Regional Committee on Human Research at the Hospital Kladno, and the patients gave informed consent on their enrolment.

Operative technique

Laparoscopy was performed using video monitoring equipment with the patient in the lithotomy position. The telescope was inserted intraumbilically, and one 5-mm port was placed in each of the lower quadrants at the lateral edge of the rectus abdominis. In the ELC group, after diagnostic laparoscopy, bipolar and monopolar electrocautery devices (Karl Storz Endoscope, Tuttlingen, Germany) were used. In the US group, the harmonic scalpel and shears (LCS-K5 or LCS-C; UltraCision; Ethicon EndoSurgery, Johnson&-Johnson, Cincinnati, OH, USA) were applied at power levels from 1 to 5 (full power). Lower power levels allowed better coagulation, but slower cutting time. Higher power levels allowed faster transsection of relative avascular tissue. The round ligaments, infundibulopelvic ligaments, and utero-ovarian ligaments were coagulated by bipolar

Table 1 Suggested criteria for offering laparoscopic surgical staging

Suggested inclusion criteria for cervical cancer
Women with newly diagnosed untreated early cervical cancer
FIGO stage IA1 to IB1 (occult or clinical <2 cm) lesions
FIGO stage II (selected cases of MRI-suspicious lymph node)
Squamous, adenocarcinoma and adenosquamous histology
Suggested inclusion criteria for endometrial cancer
Women with newly diagnosed untreated early endometrial cancer
FIGO stage IB to IC (extent of myoinvasion)
Grading 2 to 3
Adenocarcinoma, adenosquamous carcinoma and carcinosarcoma histology
Suggested criteria for para-aortic lymph node sampling
MRI-suspicious para-aortic lymph node
Positive biopsy of pelvic lymph node
High risk endometrial cancer (grade 3 and myoinvasion >50%)

Table 2 Characteristics of women and type of surgery. *LAVH* laparoscopic assisted vaginal hysterectomy, *BSO* bilateral salpingo-oophorectomy, *PLN* pelvic lymph node, *RALVH* radical laparoscopic assisted vaginal hysterectomy, *IALN* ipsilateral axillary lymph node, *ELC* electrosurgery, *US* ultrasound

Parameter	ELC	US	P value
Number	37	82	
Age (years)	54.5 (SD±10.3)	56.6 (SD±7.4)	NS
Weight (kg)	78.1 (SD±15.7)	82.3 (SD±12.3)	NS
Previous surgery n (%)	8 (21.6)	15 (18.7)	NS
Type of surgery n (%)*			
LAVH	1 (2.7)	2 (2.4)	
LAVH, BSO	6 (16.2)	3 (3.6)	
LAVH, BSO, PLN	26 (70.2)	52 (63.4)	
LAVH, BSO, PLN, IALN	3 (8.1)	5 (6.1)	
RALVH, PLN	1 (2.7)	14 (17.1)	
PLN	0 (0)	5 (6.1)	
PLN, IALN	0 (0)	1 (1.2)	

*The statistical difference was insignificant in a comparison of type of surgery (ELC LAVH group vs. US LAVH group); (ELC LAVH + LND group vs. US LAVH + LND group)

forceps or UltraCision, by being incised, then by monopolar dissector or UltraCision. In cases of RALVH, the uterosacral and cardinal ligaments were transsected using harmonic scalpel or harmonic shears.

The origin of the uterine artery was desiccated from the hypogastric artery and afterward dissected by monopolar or UltraCision. Lymph node-bearing adipose tissue was excised from the pelvic and low para-aortic space using monopolar or ultrasonic shears. Only 5-mm instruments were used in both groups. Laparoscopically assisted surgical staging required a complete inspection of the entire peritoneal cavity. A second-look laparoscopy was then performed to secure or confirm hemostasis in cases of LAVH, TLH or LARVH. An intra-peritoneal drain was left in place until the next day. All patients received deep venous thrombosis prophylaxis in the form of low molecular weight heparin and were given prophylactic antibiotics during the procedure.

Laparoscopic assisted vaginal hysterectomy, total laparoscopic hysterectomy, and laparoscopic assisted radical vaginal hysterectomy

Our LAVH (with vaginal or laparoscopic colpotomy), TLH, and BSO techniques are described elsewhere [10]. Ultrasonographically activated shears and harmonic scalpel were used in the US group and bipolar and monopolar diathermy in the ELC group. Routine surgical procedures were used during the vaginal phase.

For the RALVH, the uterine arteries were coagulated and cut by UltraCision at their origin from the hypogastric artery. The bladder flap was incised and the bladder was dissected from the cervix down to the level of the mid-vagina. The ureteral tunnel was dissected anteriorly and medially to the ureter, reflecting the distal segment of ureter laterally, allowing for removal of the uterine artery and parametrial tissue after the ureter was unroofed. A posterior cul-de-sac peritoneal incision was then made and the rectovaginal septum was dissected, isolating the uterosacral ligaments. The uterosacral ligaments, remaining cardinal ligaments, and paracolpos were divided using UltraCision or harmonic scalpel. The vagina was incised from below and transsected, removing the upper vagina, and the uterus was delivered through the vagina. The vaginal cuff was then closed vaginally. The adequacy of ureteral dissection was determined visually, and the parametrial and vaginal tissue was measured to assess the lateral and inferior margins.

Transperitoneal pelvic lymphadenectomy and infra-aortic lymph node sampling

Dissection was begun by incising the peritoneum over the right iliac artery and extending this incision caudally along the external iliac 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. The iliac vessels can then be dissected from the psoas muscle and pulled medially, and the obturator space was then exposed via a lateral approach to ensure removal of all nodal tissue particularly in the proximal part just lateral to the common iliac artery. The same procedure was done on the contralateral side. 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.

Statistical methods

We evaluated and compared differences in the preoperative and postoperative outcomes of the two patient groups who underwent different laparoscopic techniques of lymphadenectomy for cervical and endometrial cancer: the ELC and the US groups. Differences between the two groups were determined by the Chi-squared test. Data are presented as mean ± standard deviation or as the number and percentage. P values less than 0.05 were considered significant.

Results

Laparoscopic surgical staging in either cervical or endometrial cancer was completed successfully in 117 (98.3%) women (Table 3). The outcomes of surgery and recovery are summarized in Table 4. In the electrosurgical hemostasis and ultrasound groups, the total times required to finalize the whole LASS procedure were 144.2 min and 158.7 min respectively, with no statistically significant difference between the groups.

We were unable to perform prompt and thorough hemostasis in 2 patients from the US group (successful procedure rate 97.5%) because of ineffective post-ultra-

Table 3 Surgical stage

Uterine cancer	ELC	US	Total
Endometrial cancer			
Ia (no myometrial invasion)	4 (18.8)	3 (4.4)	7 (7.8)
Ib (myometrial invasion up to 50%)	5 (22.1)	33 (49.2)	38 (42.6)
Ic (myometrial invasion >50%)	10 (45.4)	25 (37.3)	35 (39.3)
IIIa	1 (4.5)	1 (1.4)	2 (2.2)
IIIc	2 (9.0)	5 (7.4)	7 (7.8)
Lymph node positive	2 (9)	5 (7.4)	7 (7.8)
Pelvic lymph node positive	2 (9)	5 (7.4)	7 (7.8)
Infra-aortic lymph positive	0 (0)	0 (0)	0 (0)
Cervical cancer			
I A 1	2 (28.5)	3 (13.0)	5 (16.6)
I A 2	5 (71.5)	10 (43.4)	15 (50.0)
I B 1	0 (0)	4 (17.3)	4 (13.3)
Locally advanced cancer	0 (0)	6 (26.0)	6 (20.0)
Lymph node positive	0 (0)	2 (8.6)	2 (6.6)

Data are expressed as number and percentage (in parentheses)

Table 4 Outcomes of surgery and recovery

Parameters	ELC group	US group	*P* value
Total operating time (min; SD)	144.2 (±36.2)	158.7 (±28.1)	NS
Time to LAVH, BSO, PLN	148.2 (±37.8)	155.4 (±26.7)	NS
Time to RALVH	185*	207.7 (±19.8)	NS
Time to bilateral PLN	63.6 (±8.5)	61.4 (±8.1)	NS
Total blood loss (ml; SD)	205.3 (±178.8)	188.6 (±92.2)	NS
Estimated blood loss to PLN	65 (±43.2)	80 (±35.4)	NS
Hemoglobin change (g/dl; SD)	1.4 (±1.2)	1.3 (±1.1)	NS
Complete hemostasis *n* (%)	37 (100)	80 (97.5)	NS
Conversion *n* (%)	1 (2.7)	1 (1.1)	NS
Number of lymph nodes (SD)	13.7 (±3.5)	18.1 (±5.3)	<0.001
Hospital stay (days; SD)	4.2 (±1.4)	3.4 (±1.3)	NS

*Only one case

sound coagulation of venous paravaginal varices (RALVH procedure) and on the vena ovarica varices (LAVH, BSO procedure). Electrosurgery was effective in all cases. Peroperative blood loss was comparable in both groups (205.3 ml and 188.6 ml in the ELC and US groups respectively) without any significant consecutive changes in the serum hemoglobin value. The UltraCision was effective in all cases of lymphadenectomy.

The estimated blood loss during the PLN phase was similar in the two groups (65 vs. 80 ml). An overview of peri- and postoperative complications is shown in Table 5. Blood loss was minimal and only four transfusion units were required in the 3 patients with intraoperative and postoperative bleeding. We converted to laparotomy in 1 patient from the ELC group with endometrial cancer in a myomatous uterus, who had extensive intra-abdominal adhesions and uncontrolled bleeding from a trocar injury of the epigastric artery. In 1 case of PLN from the US group, the suture of the bladder injury was carried out via laparotomy at the end of the laparoscopic procedure. Also in the US group, there was one major complication necessitating the patient's return to the operating room for trocar site bleeding from a branch of the epigastric vessel. In connection with difficult extirpation of lymph nodes close to the aberrant and penetrating iliac vein, a small, superficial injury of the external iliac vein was observed in 1 ultrasonographically treated patient. The bleeding site was successfully treated using a vascular clip.

Table 5 Summary of complications

Complication *n* (%)	ELC group	US group	Total
Major			
Vascular injury	1 (2.7)	2 (2.4)	3 (2.5)
Return to the operating room	0 (0)	1 (1.2)	1 (0.8)
Transfusion	1 (2.7)	2 (2.4)	3 (2.5)
Cystotomy	0 (0)	1 (1.2)	1 (0.8)
Minor			
Fever	2 (5.4)	1 (1.2)	3 (2.5)
Inflammation of the obturator nerve	0 (0)	1 (1.2)	1 (0.8)
Subcutaneous emphysema	1 (2.7)	0 (0)	1 (0.8)
Intraoperative cardiac dysrhythmia	0 (0)	1 (1.2)	1 (0.8)
Total *n* (%)	5 (13.5)	9 (11.0)	14 (11.7)

Minor complications included postoperative fever in ELC group (n=2) and US group (n=1) respectively. Signs of inflammation and edema of the obturator nerve appeared postoperatively in 1 patient from the US group, but these subsided after anti-inflammatory and electrostimulative convalescence therapy. The statistical difference in major and minor complications between the ELC and the US group was statistically insignificant (p=0.592).

The frequency of poorly differentiated endometrial lesions (grade 2 or 3) and cervical microinvasive lesions (I A 1 or I A 2) was similar in the two groups. In the ultrasound group, cervical invasive lesions (B1) and cases of locally advanced cervical cancer followed by RALVH or pelvic lymph node dissection prevailed. The mean number of lymph nodes excised was 13.7 in the ELC group and 18.1 in the US group. There was a significant difference (p<0.001) in the lymph node yield. The hospital cost per patient was 8,100 CZC (Czech crown) in the ELC group and 9,320 CZC in the US group; the difference was statistically insignificant.

Discussion

Whether in combination with extrafascial laparoscopically assisted hysterectomy or radical laparoscopic hysterectomy, laparoscopic staging, including regional lymphadenectomy is a major component of treatment for early cervical and endometrial cancer.

Traditionally, laparoscopic surgical treatment of uterine cancer has been performed electrosurgically [2, 3]. Bipolar cautery is probably the most commonly used technique for hemostasis in uterine and ovarian vessels in the uterine plexus, infundibulopelvic ligament, and the utero-ovarian ligament.

Recently, the ultrasound scalpel was introduced into laparoscopic oncologic surgery by several groups [8–13]. This scalpel has the capacity to cut and coagulate tissue simultaneously without electric current. The harmonic Scalpel and UltraCision (Ethicon EndoSurgery, Johnson&Johnson) enables a surgeon to carry out both coagulation and vessel division with the same instrument. The advantages of US dissection include less thermal damage to the surrounding tissues and less smoke [14].

The results of our study showed that ELC and US techniques were similar in their perioperative outcomes. Our operative time and intraoperative blood losses were comparable to those published by other researchers who used either electrosurgery or UltraCision technology [8, 15,

16]. Hemostasis in laparoscopic hysterectomy with UltraCision was less effective (successful procedure rate 97.5%) than electrosurgery in only 1 case of venous bleeding in an obese patient (LAVH, BSO) and also in a case of venous paravaginal bleeding in a patient treated by RALVH for cervical cancer. In this series of lymphadenectomies, the effect of UltraCision is comparable to the successful procedure rate of electrosurgery. We appreciated the possibility of using the tip of the shears to separate particular tissue layers and remove the released lymph nodes. The disadvantages of slower coagulation compared with electrosurgery was balanced by the lack of need to change ultrasound instruments during the operation. This is proved by the fact that the average duration of pelvic lymph node dissection was 61.4 min, which was comparable with the duration (63.6 min) of the same procedure performed by the electrosurgical technique.

We confirmed malignant changes in the lymph nodes or peritoneal cytology specimen or both in 6 women in the US group and 3 in the ELC group. Spread outside the regional lymph nodes was found in 7.7% of the patients, which corresponds with figures in the literature [17]. Compared with electrosurgery, the UltraCision shears were advantageous in that they took a larger number of lymph nodes, and the difference was statistically significant ($p<0.001$). We believe that the difference is caused by the greater radicality provided by the ultrasound technique. The safe removal of the lymphatic tissue was made possible by coagulation and dissection of aberrant and penetrating veins close to the external and common iliac veins. On the other hand, the difference could be influenced by an increase in experience of laparoscopic lymph node dissection.

Nezhat et al. [8] reported a high, consistent lymph node yield throughout their study period without a demonstrable "learning curve." This was made possible by ensuring the availability of an experienced surgeon during procedures performed by less experienced surgeons at the beginning of the learning curve.

In most large series in the literature, major vascular injuries occurred in 1–10% and ureteral and bladder injuries occurred in 0.9–2.6% (Table 6). Nezhat et al. [8] reported no ureteral injuries in a series of 100 cases of laparoscopic lymphadenectomies for gynecologic malignancies performed using ultrasonographically activated shears. In their series, there was 1 bladder injury and 2 vascular injuries. In our series, there were no ureteral injuries, 1 bladder injury unrelated to the lymph node dissection, and 2 vascular injuries. A vascular injury rate of 2.4% is comparable to the rates reported in the literature [7, 8, 18–20]. However, in our series not only lymphadenectomy was assessed, but also the hysterectomy. Our study is consistent with the few previously published reports and confirms that laparoscopic radical hysterectomy with pelvic lymphadenectomy using UltraCision for selected patients with stage I cervical cancer is feasible, safe, and associated with low morbidity in the pilot phase. An important addition is the comparison of RALVH ultrasound outcomes with the results using electrosurgery [7].

There were no cases of port site metastases in our study, probably due to preventive measures, which were incorporated into our practice. We suppose that the modified laparoscopic surgical staging can decrease the likelihood of port site or vaginal cuff recurrence using clips (or coagulation) to occlude the fallopian tubes and minimal manipulation with the uterus without morcellation. Occurrence of this complication following laparoscopic surgery for uterine cancer is relatively rare and has usually been described in endometrial carcinoma or advanced cervical cancer cases [21, 22].

At present, published observations regarding complications related to ultrasound energy are scarce. Awwad and Isaacson [23] described an injury of the sigmoid intestine during lysis of adhesions with the harmonic scalpel. Irritation and subsequent inflammation of the obturator nerve in one ultrasonographically treated patient is a warning against indelicate coagulation and dissection in the obturator fossa. During dissection of lymph nodes close to the obturator nerve, laparosonic instruments should be used with increased caution, and coagulation should not be used closer than 2 mm to the nerve wall.

Nezhat et al. [8] and Giannopoulos et al. [15] found ultrasound energy to be relatively safe. Compared with electrosurgery, UltraCision appears to provide us with potential advantages. It is probably safer than electrosurgery, as no electrical energy passes to or through the patient, with no risk of electric shock from the ultrasound instrument.

Our trial illustrates that an operative technique with 5-mm ultrasound shears ensures efficient dissection, coagulation, cutting, and grasping in laparoscopic surgical staging in patients with cervical and endometrial cancers. The laparoscopic ultrasonic operative technique allows for the

Table 6 Vascular, ureteral, bladder, intestinal, and nerve complications in selected series of laparoscopic lymphadenectomy

Series	Modality	Number of patients	Complications
Childers and Surwit [2]	Electrosurgery	29	1 ureteral, 1 cystotomy
Vidauretta et al. [18]	Electrosurgery	84	1 vascular
Altgassen et al. [19]	Electrosurgery	99	3 vascular, 1 ureteral, 4 intestinal, 2 nerve impairment
Abu-Rustum et al. [7]	Electrosurgery, ABM	114	1 vascular
Kohler et al. [20]	Electrosurgery	650	7 vascular, 3 bowel, 16 nerve irritation
Nezhat et al. [8]	Ultrasound	100	1 vascular, 1 cystotomy 1 bowel obstruction
Current series	Ultrasound	82	2 vascular, 1 nerve impairment
	Electrosurgery	37	1 injury to epigastric artery

performance of secure dissection and coagulation in the vicinity of important pelvic and abdominal structures such as the bladder, ureter, and larger vessels. Furthermore, the electrosurgery was demonstrated to be superior to the UltraCision in cases of laparoscopic hysterectomy and venous ovarian or uterine varices.

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