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Original Article

Two-phase laparoendoscopic single-site cervical ligament-sparing hysterectomy: An initial experience

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Abstract

Objective: To report our initial experience with and the short-term outcomes of two-phase laparoendoscopic single-site cervical ligament-sparing hysterectomy (LESS-CLSH). **Materials and Methods:** A retrospective case study included 40 women who underwent LESS-CLSH from January 2014 to December 2016 at Buddhist Tzu Chi General Hospital. Uterine specimens were extracted through contained manual morcellation with a tissue pouch. The first phase was LESS supracervical hysterectomy and conization of the internal orifice of the cervix. The second phase was transvaginal cervical conization and cylinderization. Women with a uterus diameter of >12 cm, a broad ligament myoma, or severe pelvic adhesion were categorized into a difficult group, and others were categorized into a nondifficult group. **Results:** The difficult group required more time and had more blood loss than the nondifficult group. The mean surgical time was 187.2 ± 33.9 and 139.1 ± 20.7 min, and the mean blood loss was 533.3 ± 333.3 and 225.3 ± 168.2 mL in the difficult and nondifficult groups, respectively. The overall visual analog scale (VAS) pain scores at 0–4, 24, and 48 h after surgery were 7.1 ± 1.9, 4.2 ± 1.6, and 2.3 ± 1.5, respectively; no difference in the VAS pain scores, pain relief score, and hospitalization duration was observed between the two groups. Minor surgical complications or adverse events on follow-up were noted. Three months after surgery, the diameter and thickness of the cervix were decreased by approximately 0.5 and 1.0 cm, respectively. **Conclusion:** LESS-CLSH is a minimally invasive, safe, and feasible approach, even for difficult laparoscopic hysterectomy. Contained manual morcellation enables more controlled specimen removal than morcellation only.

Keywords: *Cervical ligament sparing, Hysterectomy, Laparoendoscopic single site, Single port*

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Introduction

Hysterectomy is one of the most common gynecological surgeries. The effect of hysterectomy on pelvic floor stability is of concern when all ligaments around the cervix are transected in total hysterectomy [1-3]. According to epidemiology studies, total hysterectomy has been associated with an increased risk of subsequent pelvic organ prolapse [4-6]. To understand the anatomical aspect of vaginal vault prolapse after total hysterectomy, researchers dissected 74 cadavers and observed that a connective tissue called paracolpium in the cardinal ligament of the cervix was ruptured; this was the critical factor that prevented prolapse of the vaginal apex and vaginal eversion [2]. Although supracervical hysterectomy preserves all the cervical ligaments, the residual endometrial gland in the cervix may cause 5%–20% of women to exhibit cyclic bleeding afterward [7-10], and the reoperation rate for symptoms related to the retained cervix was 20% [10]. In addition, these women are still at a risk of cervical cancer [11], and the incidence of adenocarcinoma in young women is rising substantially [12-14].

Laparoscopy-assisted vaginal hysterectomy (LAVH) is currently the standard approach for hysterectomy; however, in some conditions such as an extra-large or T-shaped uterus and severe pelvic adhesions, it is difficult or even unsafe to perform LAVH. The bladder and ureter may be injured before or during the transection of the cervical ligaments during total hysterectomy [15,16], particularly in difficult laparoscopic hysterectomy.

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To reduce trauma on the pelvic floor and eliminate the occurrence of cervical neoplasia and cyclic vaginal bleeding, a two-phase laparoendoscopic single-site cervical ligament-sparing hysterectomy (LESS-CLSH) was first performed in a patient with a large uterus with adenomyosis [17]. In this paper, we present our initial experience with 40 cases of LESS-CLSH.

Materials and methods

Study design and patient population

This retrospective case analysis study included 40 women who underwent LESS-CLSH from January 2014 to December 2016 at Buddhist Tzu Chi General Hospital, Hualien, Taiwan, ROC. The indications for hysterectomy were symptomatic adenomyosis or myoma. Selection criteria included a normal cervical smear and normal endometrial findings through transvaginal ultrasonography within 6 months before surgery. After being provided complete information on the advantages and disadvantages of subtotal and total hysterectomy and the detailed procedures of LESS-CLSH, these patients decided to receive LESS-CLSH. The cervical size was measured using transvaginal ultrasonography before surgery and 3 months after surgery. All women received medical care and postoperative pain control based on the same computed clinical pathway of hysterectomy after admission.

The surgical time was defined as the interval between the incision and closure of the umbilical wound. Blood loss was calculated by subtracting the total volume in the suction bottle from the irrigation fluid volume. Postoperative pain was evaluated subjectively using the visual analog scale (VAS) and objectively using pain relief scores as previously described [18]. The patients were discharged if no sign or symptom of wound infection was evident on the 3rd day after surgery and the patients felt adequately well to be discharged.

Difficult laparoscopic hysterectomy is defined as the presence of an extra-large (diameter > 12 cm) or T-shaped uterus (multiple myomas or the presence of a lower segment or broad ligamentous or cervical myoma), severe bowel or peritoneal adhesions due to endometriosis, or a prior history of surgery.

Surgical procedures and modifications after initial experiences

A vertical incision (approximately 2.5 cm) through the umbilicus was made and then inserted a wound retractor (LAGIS, Taichung, Taiwan), which was shortened by wrapping it outward. Three trocars were tied to the fingers of a surgical glove, together with a ring adaptor (an accessory of the retractor), and were connected to the retractor. LESS-CLSH was performed using a two-phase procedure [Figure 1a and b] [17]. In brief, in Phase 1, the LESS approach [Figure 1c] [19] involving supracervical hysterectomy [Figure 1a] with a cutting loop (KARL STORZ, Germany) was performed, followed by cervical internal orifice conization [Figure 1a and d] using a cutting loop (26183 MB, KARL STORZ, Germany). The uterine specimens were contained in a tissue pouch (Cook Medical Inc., Bloomington, IN, USA), and the pouch was opened at the umbilical port wound where the uterine body was cut into long strips [Figure 1e] [20]; in Phase 2, a wide excision of the cervix [Figure 1f and g], including the cervical canal [Figure 1i] and transformation zone [Figure 1j], was performed. Then, the remaining part of the cervix was sutured interruptedly with 1-0 Monocryl [Figure 1h].

To prevent delayed vaginal bleeding that occurred in the initial 20 cases, two modifications were made to the cervical wound closure for the remaining 20 cases: (1) suturing of the cervical internal orifice with V-Loc (Medtronic, Dublin, Ireland) in a continuous manner and (2) additional B-lynch suturing on the cervical external orifice if the patient had a high chance of weight-bearing after being discharged from the hospital. This method could effectively decrease delayed vaginal bleeding.

Statistical analysis

The Student's *t*-test was used to compare the means of continuous variables between groups. Chi-square test was used to evaluate the association between two categorical variables. Multiple linear regression was adopted to analyze the relationship between surgical time and explanatory variables of surgical difficulty, uterine size, and cumulative number of surgical procedures. Statistical significance was set at $P < 0.05$. All statistical analyses were performed using the SPSS software (version 17.0; SPSS Inc., Chicago, IL, USA).

Details on ethical approval

The study was conducted in accordance with the Declaration of Helsinki and was approved by the local ethics committee of the institute. Informed written consent was waived because the study was a retrospective data analysis.

Results

Clinical and surgical characteristics of the cases

The clinical and surgical characteristics of the 40 women are presented in Table 1. According to average body mass index, the women were overweight (26.4 ± 5.8). The average follow-up period was 571.1 ± 266.8 days (range 30–1020). Of the women, 52.5% were categorized into the difficult group because their uteruses were >12 cm in length (37.5%) or they exhibited severe abdominal or pelvic adhesion (17.5%) while 32.5% and 17.5% of the women had moderate or mild abdominal or pelvic adhesion, respectively. Three women required myomectomy before supracervical transection because the operative field was obstructed by lower segment or broad ligamentous myomas. Almost all the patients (97.5%) received at least one concurrent surgery. For example, 92.5% of patients received bilateral salpingectomy and 65.0% received adhesiolysis [Table 1]. One patient in the difficult group was suspected of ureteral injury during the surgery; therefore, cystoscopy and ureteroscopy were performed, and the ureter was confirmed to be intact. All women received specimen removal through manual morcellation after the specimen was contained in a tissue pouch [20].

Perioperative parameters

The overall mean surgical time was 164.4 ± 37.1 min; most of the time was spent on Phase 1 procedures (135.2 ± 45.9 min), and the Phase 2 procedures were consistently completed within 25 min [Table 2]. The difficult group clearly required more time in Phase 1 and experienced more blood loss than the nondifficult group. The mean surgical time was 187.2 ± 33.9

and 109.3 ± 28.5 min in the difficult and nondifficult groups, respectively, and the blood loss was 533.3 ± 333.3 and 225.3 ± 168.2 mL, respectively. However, one woman had a blood loss of 1200 mL due to deep venous oozing after ovarian ligament transection, and three women had shoulder pain after surgery; all of them were in the difficult group. The VAS pain scores at 0–4, 24, and 48 h after surgery were 7.1 ± 1.9, 4.2 ± 1.6, and 2.3 ± 1.5, respectively. No difference was observed in the average pain relief score and hospitalization duration between the two groups.

Minor adverse events and changes in cervical size after surgery

Delayed onset vaginal bleeding on the 9th–13th day postoperation was observed in four women [Table 3]. One of them exhibited vaginal bleeding because of the rupture of two stitches on the cervical stump and required resuturing; the others were initially treated with hemostatic gel (Monsel's Solution, Addison, NY, USA) on the cuff wound. All four women were fine after orally administered 500 mg of tranexamic acid three times per day for 1 week.

Two women who received concurrent bilateral salpingectomy had transient climacteric symptoms; one of them experienced a hot flush and one had insomnia after surgery. The women were given 2 mg of Estrada (Samosa Co., Hsinchu, Taiwan) daily for 2 months, and both symptoms disappeared.

Asymptomatic fluid accumulation in the endocervical canal was observed in four women, but no treatment was required. No residual stump infection or cyclic vaginal bleeding was noted. All cervical stumps were followed up through transvaginal sonography; they gradually healed with some stromal tissue at the apex. Three months after surgery, both the diameter and thickness of the cervix decreased by approximately 0.5–1.0 cm [Table 3].

Discussion

Compared with traditional LAVH, two main modifications were made in LESS-CLSH. First, the cervical ligaments and the vessels or nerves beside the cervix were preserved. This was accomplished using a two-phase excision of the cervical canal internally through laparoscopy and externally through

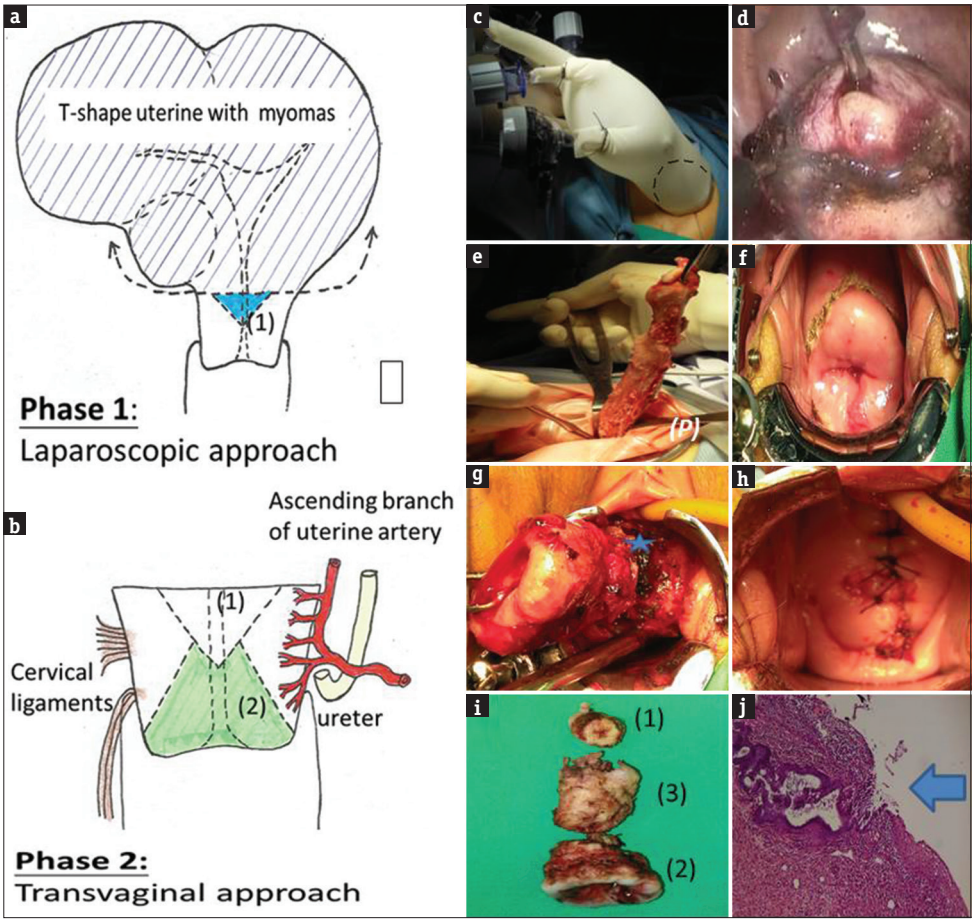

Figure 1: Overall procedure of laparoendoscopic single-site cervical ligament-sparing hysterectomy. (a and b) Schema of the two phases of laparoendoscopic single-site cervical ligament-sparing hysterectomy. Phase 1: Laparoscopic supracervical hysterectomy and conization through the internal orifice of the cervix (1). Phase 2: Transvaginal wide excision of the cervix (2). (c) Laparoendoscopic single-site setting with a wound retractor adapted with a surgical glove. (d) Cervical internal orifice conization using a hook. (e) The uterine specimens were contained in a tissue pouch (P), and the pouch was opened at the umbilical port wound where the uterine body was cut into long strips. (f) The incision line was marked in a vertical spindle shape with coagulation. (g) The cervix was cut to a depth of approximately 1 cm at 70°–80° with respect to the axis of the cervix and circumscribed until the Surgicel (blue star) was visible. (h) The remaining part of the cervix was closed using interrupted sutures with 1-0 vicryl. (i) Resected cervical specimens including the specimen from internal orifice conization (1), external orifice conization (2), and cylinderization (3). (j) Longitudinal section of the squamous–columnar junction (arrow) of the cervical specimen from the wide excision in Phase 2 (H and E, ×25)

the vagina. Second, the uterine body was removed using contained manual morcellation through the umbilical single-port opening with the aid of a wound retractor. A scalpel was used for manual morcellation. This was easily visualized through the circumferential retraction using the wound retractor. Traction of the specimen close to the abdominal skin markedly reduced the working distance to enable more accurate, faster, and safer manipulation [21], particularly in an extra-large uterus. Most importantly, these modifications increased the safety and feasibility of difficult laparoscopic hysterectomy and improved the outcome in supracervical hysterectomy.

Specimen removal with contained manual morcellation [20] in this study enabled more efficient control over the dissemination of parasitic myomas, endometrioid glands, or occult cancerous cells [22-24]. Benign sequelae of morcellation actually occurred more often than malignant dissemination of sarcomatous tissue [25-27].

Cervical coring could remove the endocervical canal during hysterectomy. Coring the cervix promoted adequate removal of endocervical glands and endometrial glands using a calibrated uterine resection tool [28] or classic intrafascial supracervical hysterectomy (CISH) instrument [29]. Adequate removal of endocervical glands and endometrial glands was reported even for cervical coring using either a 15-mm or 20-mm CISH instrument [29]. Cervical internal orifice conization and wide excision of the cervix in LESS-CLSH were more effective than cervical coring in eliminating cyclic bleeding and cervical cancer. Even though, the patients were encouraged to undergo a pap smear after surgery because vaginal intraepithelial neoplasia may also have been present.

For the initial 20 cases, four women exhibited delayed onset vaginal bleeding. Bleeding occurred during the lifting heavy objects in two women and during bicycling in one woman, whereas it was spontaneous in the fourth woman. A reasonable explanation is that the residual cervical stroma was relatively dense, and the wound edges received less blood supply compared with the mucosal cuff wound in LAVH. Therefore, the wound required a longer time and a more stable environment for healing. After we made the two modifications for the subsequent 20 cases, this problem rarely occurs.

The mean surgical time and blood loss in Phase 1 in the difficult group were higher than those in the nondifficult group [Table 2]. The probable main reason is that more than half of the women underwent difficult laparoscopic hysterectomies. A large uterus or severe adhesion requires more time for morcellation or adhesiolysis, and the preexisting high blood volume in a larger uterine body accounts for the greater blood volume loss after morcellation. When these difficult cases were excluded, the average surgical time and the blood loss were close to those of LAVH. Managing these difficult cases using LAVH would be dangerous and would require more time than LESS-CLSH. Second, to preserve

Table 1: Clinical and surgical characteristics of patients (*n*=40)

Clinical characteristics	Data
Age (year)	45.7±7.9
BMI (kg/m^2)	26.4±5.8
Parity	2.4±1.4
Uterine size (cm)	
Length	11.3±3.2
Width	8.7±3.1
Thickness	7.1±2.4
Follow-up period (day)	571.1±266.8
Difficult laparoscopic hysterectomy, *n* (%)	21/40 (52.5)
Extra-large uterus ≧12 cm	15/40 (37.5)
Severe intra-abdominal/pelvic adhesion	7/40 (17.5)
Moderate intra-abdominal/pelvic adhesion, *n* (%)	13/40 (32.5)
Mild intra-abdominal/pelvic adhesion, *n* (%)	7/40 (17.5)
Concurrent surgery/procedure, *n* (%)	
Bilateral salpingectomy	37/40 (92.5)
Adhesiolysis, *n* (%)	26/40 (65.0)
Uni/bilateral oophorectomy, *n* (%)	4/40 (10.0)
Myomectomy before hysterectomy	3/40 (7.5)
Cystoscope, *n* (%)	1/40 (2.5)
Specimen "contain before manual morcellation"	40/40 (100)

Data are presented as mean±SD or percentage (ratio). SD: Standard deviation, BMI: Body mass index

Table 2: Perioperative parameters of laparoendoscopic single-site cervical ligament-sparing hysterectomy

Perioperative parameters	All (*n*=40)	Difficult (*n*=21)	Nondifficult (*n*=19)	*P*
Surgery time (min)	164.4±37.1	187.2±33.9	139.1±20.7	<0.001*
Phase 1	135.2±45.9	155.6±47.2	109.3±28.5	0.002*
Phase 2	22.3±4.01	23.5±3.8	20.8±3.9	0.052
Blood loss (mL) (*n*=30)	387.0±307.1	533.3±333.3	225.3±168.2	0.001*
Operative complication, *n* (%)				
Blood loss ≧1000 mL	3/40 (7.5)	3/40 (7.5)	0/40 (0)	0.525
Shoulder pain	3/40 (7.5)	3/40 (7.5)	0/40 (0.0)	0.395
Ureter or bladder injury	0/40 (0.0)	0/40 (0.0)	0/40 (0.0)	-
VAS pain score at				
0-4 h after surgery	7.1±1.9	7.2±1.7	7.0±2.1	0.734
24 h after surgery	4.2±1.6	3.9±1.7	4.6±1.5	0.231
48 h after surgery	2.3±1.5	2.1±1.5	2.5±1.7	0.438
Pain relief score	1.0±0.4	1.0±0.4	1.1±0.5	0.524
Hospital stay (day)	4.2±1.0	4.4±1.1	3.9±0.8	0.087

*P<0.05. Data are presented as mean±SD or percentage (ratio). VAS: Visual analog scale, SD: Standard deviation

cervical ligaments, internal and external cervical orifice conization was performed in approximately 30 min. This process can be improved through cervical coring using a transvaginal power morcellator and screw as a guide [28,30]. The closure of the cervical orifice using this technique is easier and less time consuming. Third, to prevent iatrogenic parasitic myoma or occult cancer cell dissemination, we removed the uterine body through "contained manual morcellation" with a tissue pouch [20] in all women. In addition, almost all (97.5%) the women had one or more concurrent surgical procedures. Finally, this new procedure has a learning curve; the surgical time decreased with the increase in the number of operations [Figure 2].

LESS-CLSH may have potential complications. The bowel or adjacent organs could be injured during cervical transection or internal orifice conization. Surgeons should ensure that other hollow organs are not encircled by the cutting loop before cervical transection. The ascending uterine artery could also be injured during internal orifice conization. To prevent these potential complications, particular attention was paid to properly manipulating and fixing the cervix with the uterine elevator during internal orifice conization.

Table 3: Postoperative 3-month outcomes of laparoendoscopic single-site cervical ligament-sparing hysterectomy

Postoperative outcomes	Data (n=40)	P
Adverse events, n (%)		
Delayed onset vaginal bleeding	4/40 (10.0)	
Transient climacteric symptoms	2/40 (5.0)	
Residual stump infection	0/40 (0.0)	
Cyclic vaginal bleeding	0/40 (0.0)	
Asymptomatic minimal fluid accumulation in the residual endocervical, n (%)	4/40 (10.0)	
Cervical size changes		
Diameter before surgery	33.7±5.6	0.002*
Diameter at 3 months	27.3±7.9	
Thickness before surgery	28.4±6.3	<0.001*
Thickness at 3 months	20.5±6.4	

*P<0.05. Data are presented as percentage (ratio) or mean±SD.
SD: Standard deviation

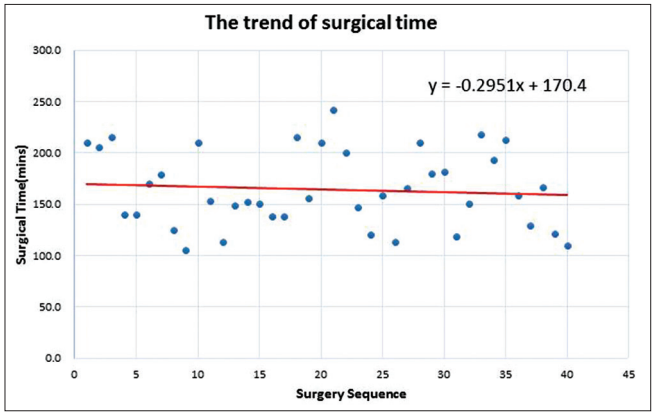

Figure 2: Scatter plot of operative time compared with the sequence of surgical procedures performed by the surgeon over the 40 cases of laparoendoscopic single-site cervical ligament-sparing hysterectomy. The smoothed line was generated using a cubic spline routine

Conclusion

Based on the preceding discussion and speculation, we conclude that LESS-CLSH is minimally invasive, safe, and feasible even for difficult laparoscopic hysterectomy cases. LESS-CLSH may maintain pelvic floor stability and eliminate the occurrence of cyclic vaginal bleeding and cervical cancer observed in subtotal hysterectomy [31,32]. Specimen removal with containment before manual morcellation enables more efficient control over the dissemination of endometrioid glands, parasitic myomas, or occult cancerous cells. However, a larger scale comparative study is warranted to determine the effects of LESS-CLSH in improving quality of life and sexual life and in preventing pelvic floor dysfunctions in the future.

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Conflicts of interest

There are no conflicts of interest.

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