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GENERAL GYNECOLOGY

Abdominal, multi-port and single-port total laparoscopic hysterectomy: eleven-year trends comparison of surgical outcomes complications of 936 cases

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Abstract
Purpose To compare surgical outcomes and complications of 284 patients who had total abdominal hysterectomy (TAH), 366 patients who had multi-port access total laparoscopic hysterectomy (MPA-TLH), and 286 patients who had single-port access total laparoscopic hysterectomy (SPA-TLH) using a transumbilical single-port system.
Methods A retrospective study was conducted on a cohort of women who underwent TAH, MPA-TLH, or SPA-TLH for benign gynecologic diseases at DaeJeon St. Mary's Hospital, between January 2003 and December 2013. Surgical outcomes and complications were compared between the three groups.
Results The total operative time (min) was longest in the SPA-TLH group (188.3 ± 51.3), followed by the TAH (176.4 ± 47.9) and MPA-TLH (149.3 ± 59.5) groups ($p < 0.05$). The estimated blood loss (mL) did not differ between MPA-TLH and SPA-TLH (163.8 ± 168.9 vs. 176.9 ± 197.8 mL), but it was the greatest in TAH (427.1 ± 250.6, $p < 0.05$). The weight of the uterus (gm) was highest in TAH (375.8 ± 380.1, $p < 0.05$) and similar in MPA-TLH and SPA-TLH (10.1 ± 2.6 vs. 9.7 ± 2.6 cm). The hospital stay (days) was longest in the TAH (7.0 ± 2.1) and SPA-TLH (6.3 ± 2.0) groups, followed by the MPA-TLH (5.5 ± 2.0) group ($p < 0.05$). The major complication rate was 2.5 % (7 cases) in the TAH group, 5.5 % (20 cases) in the MPA-TLH group, and 0.7 % (2 cases) in the SPA-TLH group. In the MPA-TLH group, the complication rate of the first half of the cases was significantly higher than in the latter half of cases, especially with regards to vaginal cuff dehiscence ($p < 0.05$). In the SPA-TLH group, no statistically significant difference was found between the two sub-groups.
Conclusions Our study showed that MPA-TLH and SPA-TLH were feasible and safe when compared to TAH. Furthermore, after acquiring technical skills in laparoscopic surgery, conversion from MPA-TLH to SPA-TLH might be easier than the initial conversion from laparotomy to laparoscopy. The advantage of SPA-TLH over MPA-TLH is questionable, considering the longer learning curve; however SPA-TLH is an effective alternative for both the patient and surgeon.

Keywords Hysterectomy · Complication · Single-port · Multi-port · TLH

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Introduction

One of the most significant innovations in surgery has been the transition from laparotomy to laparoscopy. The first laparoscopic approach to hysterectomy, total laparoscopic hysterectomy (TLH), was initially described in 1989. Since then, TLH has been considered not only an alternative to abdominal hysterectomy but rather the treatment of choice [1]. Laparoscopy has several important advantages over laparotomy, which include less pain, reduced recovery time, shorter hospital stay, early return to normal activities and avoidance of a large operative scar, and thus, within a short period of time, laparoscopy has become a preferred

surgical method [2, 3]. Surgical efforts since then have focused on maximizing the profits of minimally invasive surgery by reducing the number and size of abdominal wall incisions. In recent years, laparoendoscopic single-site (LESS) surgery has emerged as a growing trend in minimally invasive surgeries, including total hysterectomy [4]. Single-port access is preferred among women undergoing gynecologic surgery who have cosmetic concerns about skin incisional scarring. Furthermore, these approaches result in clinical outcomes comparable to standard laparoscopic surgery, and perioperative morbidity rates have been reported to be low [5–9]. Total abdominal hysterectomy (TAH), multi-port access total laparoscopic hysterectomy (MPA-TLH) or single-port access total laparoscopic hysterectomy (SPA-TLH) have been chosen based on the indication for surgery, uterine size, previous operative history, patient's general condition, patient's preference and the surgeon's experience and skill. However, laparoscopic hysterectomy has a longer learning curve, takes longer to perform and has been known to have a higher complication rate than abdominal hysterectomy, especially during the learning curve [10]. Additionally, the selection standard for the different laparoscopic hysterectomy approaches remains unclear. Due to rapid changes in laparoscopic techniques, many surgeons face the dilemma of selecting the proper surgical method for each patient.

The aim of our retrospective study was to compare the operative data and postoperative outcomes and complications of different hysterectomy approaches for benign gynecological conditions in women at a single medical center in a given period of time. This study could provide clues to define benefits and drawbacks of each surgical approach, including single-port surgery, and the study could reveal obstacles faced when changing the surgical technique.

Materials and methods

Patients

A retrospective study was conducted on a cohort of women who underwent TAH, MPA-TLH, or SPA-TLH for benign gynecologic diseases at DaeJeon St. Mary's Hospital in Korea, between January 2003 and December 2013. The gynecology department is well experienced in minimally invasive surgery. Exclusion criteria included suspicion of malignancy or the need for simultaneous interventions, such as uterine prolapse repair.

MPA-TLH and SPA-TLH have been performed at our institute since 1998 and 2011, respectively. Surgical techniques were chosen based on the clinical situation and the surgeon's skill and preference. Surgical outcomes and complications were compared between the three groups. Nine hundred and thirty-six patients who underwent total hysterectomy during the study period were enrolled in this study. Three gynecologists performed most procedures, and each physician performed every type of surgery. This study was performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki, and the research protocol approved by our Institutional Review Board.

Surgical procedures

SPA-TLH

All patients had general anesthesia and received preoperative antibiotic prophylaxis. After partial eversion of the umbilicus, a 1.5–2.0 cm-sized vertical transumbilical skin incision was made. Subsequently, a rectus fasciotomy and peritoneal incision was performed. A *trans*-umbilical single-port system was fashioned using Octoport™ (Dalim, Seoul, Korea) that consisted of a retractor and cap component with a harbor mounted onto the retractor component and multiple channels permitting introduction of laparoscopic instruments and a scope (Fig. 1). The uterus was manipulated using a Karl Storz Clermont-Ferrand uterine manipulator (Karl Storz, Tuttlingen, Germany). All vascular pedicles were secured by bipolar coagulation and sectioned using scissors. Vaginal cuff suturing was done laparoscopically using extracorporeal knot tying.

Fig. 1 Octoport™ single-port system

MPA-TLH

Two additional 5-mm trocars were inserted for instrumentation in addition to the 11-mm camera port at the umbilicus. All procedures were similar to SPA-TLH, except for trocar insertion techniques.

Surgical outcomes

Patients' demographic characteristics, including age, BMI, parity, previous abdominopelvic surgery and indication of hysterectomy, were recorded. Total blood loss was calculated from the blood lost in suction, gauzes and drapes. The operation time was recorded from the first incision to the end of the last skin suture. The weight of the uterus was determined by pathologists. The length of the hospital stay was calculated by subtracting the admission date from the discharge date with a same-day stay coded as 1 day.

Urinary injury, including bladder and ureteral injury, bowel injury, vaginal complications, including bleeding and dehiscence, and wound infection were monitored to compare complications among the hysterectomy groups. The major operative complications were defined as bowel, bladder, ureter, major vessel injuries, incision herniation, intra-abdominal bleeding and vaginal cuff dehiscence. Vaginal cuff dehiscence was defined as a visually confirmed opening of the vaginal cuff, with or without visceral organ herniation. Minor operative complications were defined as vaginal bleeding and wound infection. Vaginal bleeding was defined as postoperative vaginal cuff bleeding that required an additional outpatient department visit, apart from routine checkup, transfusion or additional transvaginal sutures to stop bleeding without dehiscence.

Statistical method

All statistical analysis was performed using the Statistical Package for Social Sciences (SPSS, Version 18 for Windows; SPSS, Inc., Chicago, IL, USA). All tests were conducted using a p value of 0.05 for statistical significance. The data were expressed as mean ± standard deviation (SD) for continuous variables and as number of cases (n) and percentage of occurrence (%) for categorical variables.

Group differences were analyzed by Chi-square test and Fisher's exact test for categorical data, and by analysis of variance (ANOVA) for continuous variables. When the ANOVA test revealed a difference within the three treatment groups, a post hoc comparison using the Sheffe test was used.

Results

Out of a total of 936 women, 284 (30.3 %) underwent TAH, 366 (39.1 %) underwent MPA-TLH, and 286 (30.6 %) underwent SPA-TLH using a transumbilical single-port system. Indications for hysterectomy are shown in Table 1. For the exception of age, there were no significant

Table 1 Demographic characteristics of each group (TAH vs. MPA-TLH vs. SPA-TLH, $n = 936$)

	TAH ($n = 284$)	MPA-TLH ($n = 366$)	SPA-TLH ($n = 286$)	p value
Age (years) (mean ± SD)	46.3 ± 7.6	47.7 ± 7.4	48.8 ± 8.1	0.000
BMI (kg/m^2) (mean ± SD)	25.0 ± 3.6	24.9 ± 3.6	24.7 ± 3.6	0.582
Parity (mean ± SD)	2.1 ± 1.1	2.1 ± 1.0	2.1 ± 0.9	0.992
Previous abdominopelvic surgery, n (%)				
Tubal operation	60 (21.1)	31 (8.5)	20 (7.0)	0.000
Adnexal operation	18 (6.3)	17 (4.6)	11 (3.8)	0.370
Myomectomy	4 (1.4)	9 (2.5)	8 (2.8)	0.502
Appendectomy	24 (8.5)	26 (7.1)	26 (9.1)	0.635
Cesarean section	62 (21.8)	53 (14.5)	39 (13.6)	0.013
Repeat cesarean section × 2	5 (1.8)	28 (7.7)	10 (3.5)	0.001
Repeat cesarean section × 3	0 (0.0)	4 (1.1)	4 (1.4)	0.158
Others	11 (3.9)	5 (1.4)	11 (3.8)	0.084
Indication of hysterectomy, n (%)				
Myoma	162 (57.0)	224 (61.2)	183 (64.0)	0.232
Adenomyosis	61 (21.5)	55 (15.0)	49 (17.1)	0.098
Endometriosis	4 (1.4)	4 (1.1)	8 (2.8)	0.224
DUB	1 (0.4)	18 (4.9)	11 (3.8)	0.004
CIN2.3	11 (3.9)	16 (4.4)	8 (2.8)	0.003
Benign ovarian neoplasm	7 (2.5)	20 (5.5)	28 (9.8)	0.001
Myoma with adenomyosis	40 (14.1)	49 (13.4)	23 (8.0)	0.048
EMH	3 (1.1)	4 (1.1)	5 (1.7)	0.702
Others [a]	4 (1.4)	4 (1.1)	5 (1.7)	0.777

TAH total abdominal hysterectomy, *MPA-TLH* multi-port access total laparoscopic hysterectomy, *SPA-TLH* single-port access total laparoscopic hysterectomy, *n* number

[a] Others, chronic pelvic pain and tubal cyst

Table 2 Complications and surgical outcomes of each group

	TAH ($n = 284$)	MPA-TLH ($n = 366$)	SPA-TLH ($n = 286$)	p value**
Surgical outcomes (mean ± SD)				
Total operative time (min)	176.4 ± 47.9	149.3 ± 59.5	188.3 ± 51.3	0.00 (B < A < C)*
Estimated blood loss (mL)	427.1 ± 250.6	163.8 ± 168.9	176.9 ± 197.8	0.00 (B, C < A)*
Largest dimension of uterus (cm)	11.9 ± 3.2	10.1 ± 2.6	9.7 ± 2.6	0.00 (B, C < A)*
Weight of extirpated uterus (g)	375.8 ± 380.1	258.7 ± 148.8	262.9 ± 194.7	0.00 (B, C < A)*
Hospital stay (days)	7.0 ± 2.1	5.5 ± 2.0	6.3 ± 2.0	0.00 (B < C < A)*
Complications, n (%)				
Major	7 (2.5)	20 (5.5)	2 (0.7)	0.002
Bladder	1 (0.4)	4 (1.1)	1 (0.3)	0.382
Ureteral	0 (0.0)	5 (1.4)	1 (0.3)	0.073
Bowel	2 (0.7)	3 (0.8)	0 (0.0)	0.324
Dehiscence	4 (1.4)	9 (2.5)	0 (0.0)	0.029
Minor	8 (2.8)	15 (4.1)	5 (1.7)	0.212
Bleeding	1 (0.4)	12 (3.3)	3 (1.0)	0.010
Wound infection	7 (2.5)	3 (0.8)	3 (1.0)	0.173
Total complications	15	35	7	
No. of women with complications	15 (5.3)	32 (8.7)	7 (2.4)	0.003

n number

* A, TAH; B, MPA-TLH; C, SPA-TLH

** ANOVA test and Sheffe test

differences in characteristics of patients who underwent different procedures ($p < 0.05$).

The outcomes of the TAH group vs. MPA-TLH group vs. SPA-TLH group are shown in Table 2. The total operative time was longest in the SPA-TLH group, followed by the TAH and MPA-TLH groups ($p < 0.05$). The estimated blood loss did not differ between MPA-TLH and SPA-TLH, while the TAH group showed the greatest blood loss ($p < 0.05$). The uterine size was estimated from both the largest dimension of the uterus found on ultrasound and the weight of the extirpated uterus. The largest uterine dimension was found in the TAH group ($p < 0.05$), and uterine dimension was similar in MPA-TLH and SPA-TLH. The weight of uterus was greatest in the TAH group ($p < 0.05$) and similar in MPA-TLH and SPA-TLH groups. The hospital stay was longest in the TAH group, followed by the SPA-TLH and MPA-TLH groups ($p < 0.05$).

The major complication rate was 2.5 % (7 cases) in the TAH group, 5.5 % (20 cases) in the MPA-TLH group and 0.7 % (2 cases) in the SPA-TLH group, as shown in Table 3. Bladder injury occurred in six women, including one woman in the TAH group, four women in the MPA-TLH group, and one woman in the SPA-TLH group ($p = 0.382$). Ureteral injury occurred in six women, including five women in the MPA-TLH group and one woman in the SPA-TLH group ($p = 0.073$). Bowel injury occurred in five women, including two women in the TAH group and three women in the MPA-TLH group ($p = 0.324$). There were nine cases of vaginal dehiscence in the MPA-TLH group, four cases in the TAH group and none in the SPA-TLH group ($p < 0.05$). The minor complication rate was 2.8 % in the TAH group, 4.1 % in the MPA-TLH group, and 1.7 % in the SPA-TLH group. Vaginal bleeding occurred in one woman in the TAH group, 12 women in the MPA-TLH group, and three women in the SPA-TLH group ($p < 0.05$). Wound infection occurred in 13 women, including seven women in the TAH group, three women in the MPA-TLH group, and three women in the SPA-TLH group. Figure 2 shows the number of operations in the TAH, MPA-TLH, and SPA-TLH groups, major complications and unplanned intra-operative laparotomy conversion from 2003 to 2013.

Table 3 shows comparative complication results between MPA-TLH and SPA-TLH divided into two operation periods. In the MPA-TLH group, the complication rate of the initial half of cases was significantly higher than the latter half of cases, especially with regards to stump dehiscence and vaginal bleeding ($p < 0.05$). However, in the SPA-TLH group, no statistically significant difference was found between these two sub-groups. The first SPA-TLH at our institution was performed in 2011. There was no significant difference between the complications rates of the MPA-TLH and SPA-TLH groups after 2011.

There were 18 cases of unplanned intra-operative laparotomy conversion during laparoscopic operation. Seventeen cases were from the MPA-TLH group and one case

Table 3 Comparison of complications between MPA-TLH and SPA-TLH divided in two by periods of performed operation

Complications	MPA-TLH		*p* value	SPA-TLH		*p* value
	Preceding half cases ($n = 183$) *n* (%)	Latter half cases ($n = 183$) *n* (%)		Preceding half cases ($n = 143$) *n* (%)	Latter half cases ($n = 143$) *n* (%)	
Major	17 (9.3)	3 (1.6)	0.002	0 (0.0)	2 (1.4)	0.498
Bladder	2 (1.1)	2 (1.1)	0.999	0 (0.0)	1 (0.7)	0.999
Ureteral	5 (2.7)	0 (0.0)	0.061	0 (0.0)	1 (0.7)	0.999
Bowel	3 (1.6)	0 (0.0)	0.248	0 (0.0)	0 (0.0)	
Dehiscence	8 (4.4)	1 (0.5)	0.037	0 (0.0)	0 (0.0)	
Minor	11 (6.0)	4 (2.2)	0.111	3 (2.1)	2 (1.4)	0.685
Bleeding	8 (4.4)	4 (2.2)	0.380	2 (1.4)	1 (0.7)	0.999
Wound infection	3 (1.6)	0 (0.0)	0.248	1 (0.7)	2 (1.4)	0.999
Total complications	28	7		3	4	
No. of women with complications	25 (13.7)	7 (3.8)	0.001	3 (2.1)	4 (2.8)	0.999
No. of conversion to laparotomy	12(6.6)	5(2.7)	0.134	1 (0.7)	0 (0.0)	0.999

n number

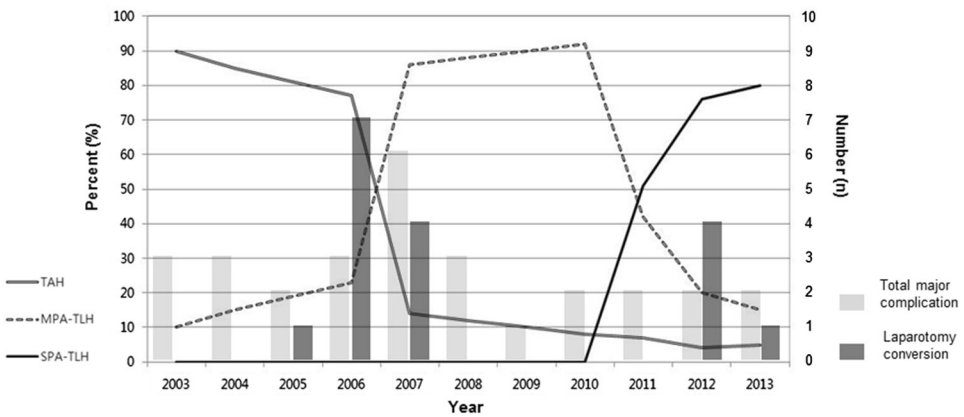

Fig. 2 The rate of operation in group of TAH, MPA-TLH, SPA-TLH in Daejeon St. Mary's hospital from 2003 to 2013. The number of total major complication and unplanned intra-operative laparotomy conversion were described as *light gray* and *dark gray square,* respectively

was from the SPA-TLH group. Fifteen cases were due to severe pelvic adhesion, one case was to control incidental retroperitoneal bleeding, and one case was to repair severe bladder injury. There were no incidences of mortality in the study group.

Discussion

Hysterectomy has been the most common gynecologic surgery worldwide for a long time [11]. The desire for less invasive surgery and the ability of surgeons to update surgical skills has contributed to the significant recent developments in laparoscopic surgery, including LESS. The surgical methods have changed rapidly during the last decade such that the indication and advantage of each method have not been adequately defined. To make the appropriate choice of surgical method for each individual case requires that the difference of each method be explored more clearly.

In our institute, the hysterectomy method has changed based on the recent shift from laparotomy to MPA-TLH and finally to SPA-TLH. As shown in Table 1, there were no significant differences among patient characteristics of each group, except for age. The age difference in each group might reflect recent trends of conservative care for benign gynecologic disease rather than the difference of each operative method. The growing desire to preserve the uterus might result in a greater age at which hysterectomy is performed. Patients may prefer being treated with medicine and/or a more conservative surgery such as myomectomy.

Surgical outcomes and complications were different in each group (Table 2). The total operative time was longest in the SPA-TLH group followed by the TAH and MPA-TLH groups. SPA-TLH had a longer intra-abdominal operation time compared to MPA-TLH. Lee et al. [12] reported no difference in hospital stay or operation time between conventional and single-port laparoscopically assisted vaginal hysterectomy. In contrast, our study showed that SPA-TLH had both a longer time of operation and hospital stay, and these findings were in agreement with YS Choi et al. [13] who reported that LESS needed more time due to installation of the single-port system and difficult intra-abdominal manipulation resulting from a loss of triangulation. TAH required a longer operating time than MPA-TLH likely due to the time spent on opening and closing the abdominal wall. Moreover, TAH tends to be indicated in more problematic cases, including severe pelvic adhesion and an enlarged uterus. The hospital stay was longest for those undergoing TAH followed by SPA-TLH and MPA-TLH. Reduction of postoperative pain could shorten the hospital stay length. Although the difference in postoperative pain between multi-port surgery and LESS is still controversial, some researchers reported higher immediate postoperative pain scores in patients who underwent single-port surgery compared to multi-port surgery after cholecystectomy and appendectomy [14, 15]. They suggested that longer operative time may translate to greater stretching of the single umbilical wound and subsequently more postoperative pain. Our comparative study on post-operative pain between SPA-TLH and MPA-TLH based on analgesic dose and visual analogue scale (VAS) pain scores is now ongoing. Though it has not been completed yet, no statistically significant difference has been found to date. In our study, the length of hospitalization is extraordinarily high in all groups compared with other reports. This is associated not only with the medical condition but also with the unusual culture of hospitalization in Korea, where even patients who received laparoscopy without complication want to stay as long as possible. It may also pertain to relatively low medical expenses in Korea. On the first postoperative day, most patients who underwent laparoscopic surgery can ambulate and eat meals with little difficulty.

Major complication rates vary based on the type of hysterectomy. The report by McPherson et al. [16] showed the rate of severe operative complications with LAVH (6.1 %) to be double the rate of abdominal hysterectomy (3.6 %). Magrina et al. [17] reported that the overall laparoscopic complication rate ranged from 0.2 to 10.3 %. Our study showed that the major complication rate was 2.5 % in the TAH group, 5.5 % in MPA-TLH group and 0.7 % in the SPA-TLH group (Table 3). According to Kim et al., the complication rate of TLH was 2.0 %, which was lower than our MPA-TLH result. This study is retrospective and includes whole data for a certain period of time in one large medical center. Thus, this unfiltered data include high complication cases that occurred during the procedure learning curve. Such characteristics of this manuscript could lead to statistical misunderstandings and make new surgical approaches seem risky or complicated. As shown in Table 3, the major complication of MPA-TLH occurred mostly during the first half of cases (9.3 %) and was considerably decreased (1.6 %) in the latter half of cases, which was similar or lower than complication rates of other reports. Park et al. reported a 2.1 % complication rate for SPA-TLH, which was higher than the 0.7 % complication rate of SPA-TLH in our study [18]. In the MPA-TLH group, the complication rate of the first half of cases was significantly higher than the latter half of cases, especially with regards to vaginal cuff dehiscence and vaginal bleeding. It was suggested that the surgeon experienced difficulty in vaginal cuff suturing especially during the initial period of laparoscopy introduction.

Makinen et al. [8] reported that laparoscopic hysterectomy had a longer learning curve and higher complication rate than abdominal hysterectomy, especially during the learning curve. Table 3 shows that the difference in experience could result in different surgical outcomes. The result that complications were mostly in the initial half of MPA-TLH cases suggests that the great paradigm shift from open trans-abdominal surgery to laparoscopic surgery involves trial and error in the surgeon's technique. The complication rate of MPA-TLH did not differ from that of SPA-TLH after the SPA-TLH technique was introduced. This suggests that after being technically skilled in laparoscopic surgery, conversion from MPA-TLH to SPA-TLH was not a big challenge, which is in accordance with recent reports that state that LESS resulted in comparable clinical outcomes to standard laparoscopic surgery with overall low rates of major perioperative morbidity [5–9].

The recent shift in surgical methods for hysterectomy has been so rapid and widespread that identification of the advantages and limitations of each method are not clear. Our study showed that SPA-TLH and MPA-TLH were feasible and safe, with TAH and laparoscopy proving advantageous to laparotomy in terms of pain reduction, reduced recovery time, shorter hospital stay and avoidance of a large operative scar. Although there was no clear advantage in performing SPA-TLH over MPA-TLH, SPA-TLH should be considered by both the patient and the surgeon. Future studies comparing each surgical method are needed to define the appropriate indication for each method.

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Conflict of interest There are no conflicts of interest.

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