GENERAL GYNECOLOGY

Transumbilical single-port access versus conventional total laparoscopic hysterectomy: surgical outcomes

Ga Won Yim, MD; Yong Wook Jung, MD; Jiheum Paek, MD; San Hui Lee, MD; Ha Yan Kwon, MD; Eun Ji Nam, MD; Sunghoon Kim, MD; Jae Hoon Kim, MD; Young Tae Kim, MD; Sang Wun Kim, MD

OBJECTIVE: The objective of the study was to compare surgical outcomes and postoperative pain between transumbilical single-port access total laparoscopic hysterectomy (SPA-TLH) and conventional 4-port total laparoscopic hysterectomy (TLH).

STUDY DESIGN: We retrospectively reviewed 157 patients who underwent SPA-TLH (n = 52) or conventional TLH (n = 105). A single-port access system consisted of a wound retractor, surgical glove, 2 5 mm trocars, and 1 10/11 mm trocar.

RESULTS: The SPA-TLH group had less intraoperative blood loss ($P < .001$), shorter hospital stay ($P = .001$), and earlier diet intake ($P < .001$) compared with the conventional TLH group. There was no difference in perioperative complications. Immediate postoperative pain score was lower in the SPA-TLH group ($P < .001$). Postoperative pain after 6 and 24 hours was lower in SPA-TLH with marginal statistical significance.

CONCLUSION: SPA-TLH is a feasible method for hysterectomy with lower immediate postoperative pain and better surgical outcomes with respect to recovery time compared with conventional TLH.

Key words: hysterectomy, laparoscopy, pain, single-port access

Cite this article as: Yim GW, Jung YW, Paek J, et al. Transumbilical single-port access versus conventional total laparoscopic hysterectomy: surgical outcomes. Am J Obstet Gynecol 2010;203:26.e1-6.

Laparoscopy has several advantages over laparotomy including improved cosmesis, shorter length of hospital stay, faster return to normal activities, lower cost, and reduced pain.[1] Several investigators have demonstrated the feasibility of a laparoscopic approach for gynecologic procedures, the most common being laparoscopic hysterectomy.[2,3] Minimally invasive procedures such as laparoscopy are becoming the current trend and are constantly improving with advances in surgical instrumentation and technique.

From the Women's Cancer Clinic, Severance Hospital, Division of Gynecologic Oncology, Department of Obstetrics and Gynecology, Yonsei University College of Medicine, Seoul, Korea (all authors).

Received Sept. 2, 2009; revised Nov. 3, 2009; accepted Feb. 10, 2010.

Reprints: Sang Wun Kim, MD, PhD, Women's Cancer Clinic, Severance Hospital, Division of Gynecologic Oncology, Department of Obstetrics and Gynecology, Yonsei University College of Medicine, 250 Seongsanno, 134 Shinchon-dong, Seodaemun-gu, 120-752 Seoul, Republic of Korea. san1@yuhs.ac.

0002-9378/$36.00

doi: 10.1016/j.ajog.2010.02.026

Recently single-port access (SPA) laparoscopic surgery has been introduced into the field of minimally invasive surgery and implemented in gynecologic procedures. In fact, a single-port approach had already been used in the gynecologic field; in the 1970s, laparoscopic tubal ligations were performed with Yoon's ring through a single umbilical incision,[4] and Pelosi and Pelosi[5] performed total hysterectomy with bilateral salpingo-oophorectomy using the single-puncture technique in 1991. However, this procedure did not initially gain popularity because of technical challenges. Since then, technological innovations in the field of laparoscopic surgery have been remarkable, allowing complicated procedures such as cholecystectomy, appendectomy, nephrectomy, and sacrocolpopexy using single-port access.[6-9]

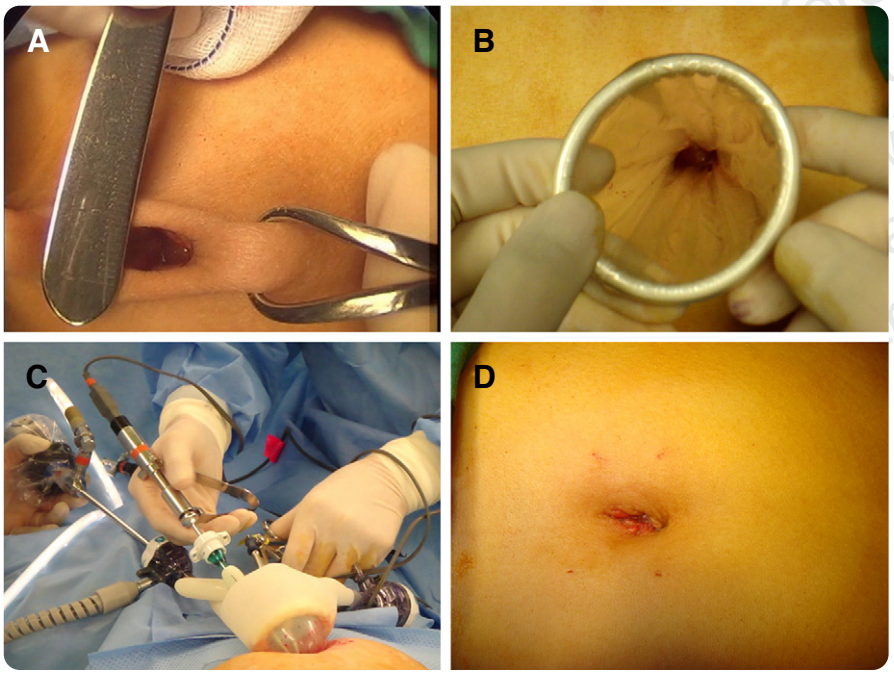
The technology and techniques used in laparoscopic procedures are still evolving, yet there are limited numbers of studies demonstrating the feasibility of single-port access laparoscopic hysterectomy. Lee et al[10] reported SPA-laparoscopic-assisted vaginal hysterectomy. However, there are no reports of total laparoscopic hysterectomy (TLH) using a single multichannel port. Since 2008, with the recent progression in laparoscopic skills and instrumentation, we have successfully performed SPA-TLH. In this study, we present our experience with SPA-TLH and a retrospective comparative analysis of surgical outcomes including postoperative pain for SPA-TLH and conventional TLH.

Materials and Methods

The study was approved by the Institutional Review Board at Yonsei University College of Medicine. We evaluated 157 patients who underwent SPA-TLH (n = 52) or conventional TLH (n = 105) for benign gynecological conditions from June 2004 to July 2009 at the Department of Obstetrics and Gynecology, Severance Hospital, Yonsei University College of Medicine in Seoul, Korea. Conventional TLH using 4 ports was performed in our institution until August 2008 when SPA laparoscopic surgery was introduced for adnexal surgery and hysterectomy.

All hysterectomies were performed by 2-surgeon teams. After general anesthesia, patients were placed in the lithotomy position. A RUMI uterine manipulator was placed with a KOH Colpotomizer system (Cooper Surgical Inc, Trumbull,

FIGURE 1
Photograph demonstrating a single-port access system



A, A 1.2 mm vertical intraumbilical skin incision was made for entry into the peritoneal cavity with a #11 scalpel. **B,** The wound retractor (Alexis; Applied Medical, Rancho Santa Margarita, CA) was inserted through the incision. **C,** External view during a single-port access transumbilical total laparoscopic hysterectomy. **D,** Postoperative wound on the umbilicus shows an umbilical skin incision of approximately 12 mm.

Yim. Transumbilical single-port access vs total laparoscopic hysterectomy. Am J Obstet Gynecol 2010.

CT). Surgical instruments used were bipolar forceps, monopolar scissors, atraumatic forceps, toothed grasper, laparoscopic needle holder, and a suction-irrigation system.

Data pertaining to patient characteristics (age, parity, body mass index, and general health status), type and duration of surgery, presence of pelvic adhesion, estimated blood loss, uterine weight, postoperative pain scores, short-term postoperative complications, resumption of normal diet, and length of hospital stay were collected from medical records. Operative time was defined as the time from umbilical skin incision to completion of skin closure.

Inclusion criterion of the study was a planned hysterectomy for benign gynecologic conditions and healthy patients (American Society of Anesthesiologists classification I-II). Exclusion criteria were confirmed cervical, uterine, or ovarian malignancy; uterine size greater than 16 gestational weeks by pelvic examination; previous history of radiation therapy; and laparoscopic cases that were converted to abdominal hysterectomy.

Postoperative pain intensity was rated at rest using a visual analog scale. The scale was presented as a 10 cm line, with verbal descriptors anchored with "no pain" and "worst imaginable pain." Patients were asked to rate their pain intensity immediately after surgery in the recovery unit and at 6, 24, and 48 hours after surgery. Intraoperative analgesia consisted of intravenous fentanyl (100 μg) and ketorolac tromethamine (60 mg).

Intravenous patient-controlled analgesia (IV-PCA) was part of the postoperative pain management protocol under consent and was commenced 30 minutes prior to the end of surgery and continued for 48 hours. The standard prescription for IV-PCA was 1000 μg fentanyl, 120 mg ketorolac tromethamine, and 16 mg ondansetron HCl in 100 mL 0.9% saline. This was given in a standard 2 mL per hour infusion set, and a patient bolus of 2 mL every 15 minutes was allowed. After surgery, intravenous analgesia (60 mg ketorolac tromethamine) was given on demand.

Oral nonsteroidal antiinflammatory drugs were given regularly during the hospital stay when the patient started diet intake around postoperative day 2. Five day discharge medication was dispensed. Patients were discharged from the hospital when they were mobile with well-controlled pain, tolerated an oral diet, and resumed normal bowel and urinary functions.

Surgical techniques

Conventional TLH: a 5 or 10 mm vertical intraumbilical incision was made and a 5 or 10 mm trocar was inserted bluntly through the umbilicus before CO_2 insufflation. After creating a CO_2 pneumoperitoneum, a rigid 30°, 5 or 10 mm laparoscope was introduced, depending on the surgeon's preference. Two ancillary 5 mm trocars were placed at the McBurney and the counter-McBurney point, and another 5 mm trocar was inserted about 10 cm above the counter-McBurney point. After transvaginal specimen removal, the vaginal cuff was closed laparoscopically using 0 Polysorb sutures (Syneture, Mansfield, MA) and tied intracorporeally or extracorporeally using a Clarke-Reich knot pusher.

SPA-TLH

After making a 1.2-1.5 cm vertical intraumbilical skin incision, a 1.5-2 cm rectus fasciotomy was performed to enter the peritoneal cavity (Figure 1, A). For the SPA system, the Alexis wound retractor (Applied Medical, Rancho Santa Margarita, CA) was inserted into the peritoneal cavity through the umbilicus (Figure 1, B). The wrist portion of a size 7½ surgical glove was fixed to the outer ring of the wound retractor.

After making a small hole in one of the finger tip portions of the glove, a 5 mm trocar was inserted and advanced into the abdominal cavity. The abdomen was insufflated with CO_2 gas through this trocar to approximately 2 L, and a rigid 30°, 5 mm laparoscope was inserted.

After inspection of the pelvic cavity, 2 additional holes for accessory ports were made in the other finger tips of the glove and 1 conventional 5 mm and another 10-11 mm port were inserted through the holes. Laparoscopic forceps and graspers were inserted through these accessory ports as needed. Bipolar and monopolar electrocautery and the LigaSure system (Valleylab, Boulder, CO) were used (Figure 1, C).

After placing the SPA system, the overall procedure was similar to that of conventional TLH using 4 ports. Bilateral round ligaments and tuboovarian ligaments were securely ligated and cut with the LigaSure system (Figure 2, A and B). After completely detaching the uterus from the vagina, the uterus was transvaginally extracted. Pneumoperitoneum was maintained with a surgical glove filled with normal saline.

The vaginal cuff was laparoscopically repaired with 0 Polysorb sutures in 38 of 52 cases. A 40 mm round-bodied needle was introduced through the 10 or 11 mm port and tied intracorporeally or extracorporeally using a Clarke-Reich knot pusher (Figure 2, C). Four interrupted sutures were made in total (Figure 2, D).

Among the first 26 cases, the vaginal vault was repaired transvaginally with 0 Polysorb sutures in 14 patients who had sufficient vaginal space; however, the vaginal cuff was closed laparoscopically in all of the last 12 cases. After hemostasis, the single 3-channel port was removed and the umbilical fascia and subcutaneous tissue were approximated with 2-0 Vicryl sutures (Ethicon, Piscataway, NJ) (Figure 1, D).

Statistical methods

Statistical analysis was performed with SPSS version 12 for Windows (SPSS Inc, Chicago, IL). A P value of less than .05 was regarded as statistically significant. Student t test and Mann-Whitney U test were used for parametric and nonparametric variables, respectively. Differences between proportions were compared with the χ^2 test.

RESULTS

In total, 157 patients were included in this study: 52 in the SPA-TLH group and 105 in the conventional TLH group (Table 1). None of the patients were converted to laparotomy; however, 1 patient with a dense intestinouterine adhesion in the posterior cul-de-sac area who received SPA-TLH needed an additional port on the suprapubic area to complete the procedure.

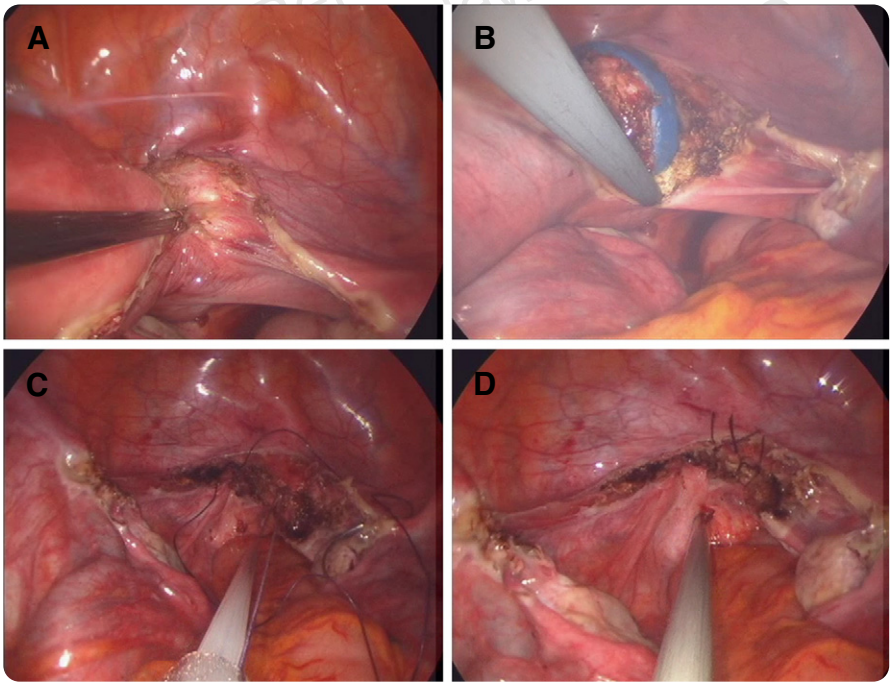
The most common surgical indication in both groups was uterine myoma. Age, body mass index, and parity were not significantly different between the groups. The median uterine weight was greater in the SPA-TLH group than in the conventional TLH group (162 vs 123.5 g; $P = .016$).

Surgical outcomes are shown in Table 2. There was no significant difference in the mean operative time between the SPA-TLH and the conventional TLH group (117.5 and 110 minutes, respectively; $P = .924$). Estimated amount of operative blood loss was greater in patients treated with conventional TLH (median, 150 mL; range, 30–750 mL) than in those treated with SPA-TLH (median, 100 mL; range, 20–600 mL; $P < .001$).

The SPA-TLH group had a shorter postoperative hospital stay (3.4 ± 1.3 vs 4.3 ± 1.6 days; $P = .001$) and an earlier initiation of general diet (1.8 ± 0.6 vs 2.2 ± 0.7 days; $P < .001$) compared with the conventional TLH group. Neither group had intraoperative complications or required transfusion during or after surgery. There was no difference in perioperative complications between the two groups (2/52 [3.8%] in the SPA-TLH vs 10/105 [9.5%] in the conventional TLH group; $P = .156$).

In the SPA-TLH group, 1 patient had a postoperative urinary tract infection and another patient had minimal serous discharge on the umbilical wound on postoperative day 10. In the conventional

FIGURE 2
Intraoperative view of a single-port access transumbilical total laparoscopic hysterectomy



A, The enlarged uterus was pushed to the left side. The right uterine vessels were skeletonized, sealed, and divided using the LigaSure system (Valleylab, Boulder, CO). **B,** The anterior right vaginal wall was cut over the Colpotomizer cup (Cooper Surgical Inc, Trumbull, CT) with a monopolar L-hook. **C,** The vaginal cuff was sutured using a laparoscopic needle holder and 0 Polysorb sutures (Syneture, Mansfield, MA) with a 40 mm round-bodied needle. **D,** Postoperative photograph of the pelvic cavity.
Yim. Transumbilical single-port access vs total laparoscopic hysterectomy. Am J Obstet Gynecol 2010.

TABLE 1
Patients characteristics by group (n = 157)

Characteristic	SPA-TLH (n = 52)	Conventional TLH (n = 105)	*P* value
Age, y; mean (SD)	48.2 (6.2)	48.8 (9.3)	.628[a]
Body mass index, kg/m^2			.633[a]
Overall, mean (SD)	23.3 (2.9)	23.0 (3.9)	
Parity			.083[b]
0	4 (7.6%)	2 (1.9%)	
≥1	48 (92.4%)	103 (98.1%)	
Patients with abdominal surgery histories	17 (32.7%)	27 (25.7%)	.565[c]
Patients with comorbidities	21 (40.4%)	25 (23.8%)	.032[c]
Indications for hysterectomy			
Uterine leiomyoma	30 (57.7%)	40 (38.1%)	
Preinvasive cervical neoplasia	10 (19.2%)	49 (46.6%)	
Gestational trophoblastic tumor	1 (1.9%)	0	
Dysfunctional uterine bleeding	1 (1.9%)	3 (2.9%)	
Endometrial pathology	3 (5.8%)	3 (2.9%)	
Ovarian tumor	7 (13.5%)	10 (9.5%)	
Patients with pelvic adhesions	6 (11.5%)	20 (19.0%)	.252[c]
Uterus weight, g; median (range)	162 (45–645)	123.5 (21–642)	.016[b]

SPA-TLH, single-port access total laparoscopic hysterectomy; *TLH*, total laparoscopic hysterectomy.

[a] The Student *t* test was used for comparison; [b] The Mann-Whitney *U* test was used for comparison; [c] The χ^2 test was used for comparison.

Yim. Transumbilical single-port access vs total laparoscopic hysterectomy. Am J Obstet Gynecol 2010.

TLH group, several other postoperative complications including urinary tract infection, hematuria, upper respiratory infection, wound infection, bowel ileus, vaginal vault bleeding and vault rupture were documented.

Thirty-nine of 52 patients (75%) in the SPA-TLH group and 80 out of 105 patients (76%) in the conventional TLH group had intravenous patient-controlled analgesia (IV-PCA). A slightly higher proportion of patients in the conventional TLH group received intravenous analgesia, but the median number of painkillers given was the same in both groups (median, 1; interquartile range, 1–4 in the SPA-TLH group vs median, 1; interquartile range, 0–2 in the conventional TLH group; $P = .007$).

Pain score measured immediately after surgery in the recovery unit was lower in the SPA-TLH group than in the conventional TLH group (mean, 3.5 vs 4.5; $P < .001$) (Table 3). The postoperative pain scores after 6 and 24 hours were lower in the SPA-TLH group with marginal significance (mean, 3.2 vs 3.6 at 6 hours; $P = .080$ and 2.6 vs 2.9 at 24 hours; $P = .052$). The postoperative pain scores after 48 hours were the same in the 2 groups (mean, 2.2 in the SPA-TLH group vs 2.3 in the conventional TLH group; $P = .872$).

Comment

The results of this study showed that SPA-TLH is a feasible method for hysterectomy with less immediate postoperative pain and operative blood loss, earlier initiation of general diet, and shorter hospital stay compared with conventional TLH at our institution. Until recently TLH using 4 ports was a standard laparoscopic procedure in our institution for benign gynecologic conditions.

In an attempt to reduce the number of ports for better cosmetic outcome and reduction of port site–related complications, single-port laparoscopy was implemented in September 2008 in our center. The current trends are aimed at performing still less invasive procedures, which are becoming possible because of advances in surgical instrumentation and techniques.

We used a single 3-channel port, which consisted of a wound retractor and a surgical glove with three trocars. This port system allowed for the use of 2 5 mm trocars and 1 10 or 11 mm trocar. Two accessory ports were used for traction, ligation, and suturing. If any clashing between the instruments occurred, 1 or 2 accessory trocars were removed and directly inserted through the glove into the wound retractor, increasing the degrees of movement for the surgical instruments (Figure 1, C).

Several studies have demonstrated that reduction in either the size or number of ports is associated with less postoperative pain.[11-13] The rationale is that smaller or fewer surgical incisions for port insertion would cause less trauma and therefore produce less pain. Given the comparable surgical outcomes of SPA-TLH and conventional TLH, we speculated that a potential benefit of a single-port procedure would be reduced postoperative pain.

In this study, the postoperative pain was reduced in SPA-TLH through the first 24 hours, but the pain score after 48 hours was not different between the 2 groups. In particular, the pain score measured immediately after surgery in the recovery unit was lower in the SPA-TLH group than in the conventional TLH group. However, immediate postoperative pain may be greatly affected by intraoperative analgesia; therefore, further evaluation of intraoperative analgesia such as the frequency and amount of medication used will be needed to accurately compare immediate postoperative pain between the two groups. Furthermore, it was interesting that single-port laparoscopy generally conferred no analgesic advantages compared with conventional TLH in our study.

Although the number of ports was reduced, stretching of the umbilical fascia and subsequent extension of the length of the skin incision seemed inevitable because of crowding and passing of the

laparoscopic instruments. This may explain why the pain scores in the late postoperative period were similar in both groups.

Regardless of access to PCA, patients were given additional painkillers on demand. The median number of painkillers given was the same in both the SPA-TLH and TLH groups; however, whether the amount of painkiller administered was concentrated in the early postoperative period was not documented.

In our experience, SPA-TLH has other advantages over conventional TLH. First, operative complications related to trocar insertion such as epigastric vessel injury, operative wound infection, hematoma, and visceral organ damage may be avoided because ancillary port penetration of the abdominal wall is not required. Second, the single-port approach through the umbilicus might offer better cosmetic results because of a decrease in the number of postsurgical scars, and indeed, postoperative follow-up showed little scarring on the skin (Figure 1, D). However, improved cosmesis may not always lead to patient satisfaction, and although previous studies have shown that cosmetic superiority results in better body image and higher quality of life,[14-16] the possible interaction of safety or risk with cosmesis has not been fully addressed.

In a study on the attitudes of patients toward scarless surgery, patient approval for such surgery decreased with a presumed increase in the surgical risk.[17] In fact, in our experience, some patients were skeptical about the completeness of the procedure after seeing a single umbilical incision despite being fully informed preoperatively. Because single-port surgery is a new, unstandardized technique that is still in the early stages of development, the risks of the different approaches should be fully explained to the patient. Cosmetic issues may then become a clear advantage of single-port surgery and may lead to increased patient satisfaction.

The major disadvantage of single-port surgery is the limitation of movement caused by collisions of the laparoscopic instruments. Suturing of the vaginal cuff was especially difficult because of the

TABLE 2
Comparison of surgical outcomes between SPA-TLH and conventional TLH (n = 157)

Outcome	SPA-TLH (n = 52)	Conventional TLH (n = 105)	*P* value
Operating time, min			
Overall, median (range)	117 (54–195)	110 (45–253)	.924[a]
Estimated blood loss, mL			
Overall, median (range)	100 (20–600)	150 (30–750)	< .001[b]
Initiation of general diet intake, d			
Mean (SD)	1.8 (0.6)	2.2 (0.7)	< .001[a]
Length of hospital stay, d			
Mean (SD)	3.4 (1.3)	4.3 (1.6)	.001[a]
Perioperative complication rates, total	2 (3.8%)	10 (9.5%)	.156[c]
Urinary tract infection	1 (1.9%)	2 (1.9%)	
Hematuria	0	1 (1.0%)	
Upper respiratory infection	0	1 (1.0%)	
Wound infection	1 (1.9%)	1 (1.0%)	
Postoperative ileus	0	2 (1.9%)	
Vault bleeding	0	2 (1.9%)	
Vault rupture	0	1 (1.0%)	
Patients with IV-PCA	39 (75.0%)	80 (76.2%)	.870[c]
Number of painkillers given			.007[b]
Median	1	1	
Interquartile range	1–4	0–2	

IV-PCA, intravenous patient-controlled analgesia; *SPA-TLH*, single-port access total laparoscopic hysterectomy; *TLH*, total laparoscopic hysterectomy.

[a] The Student *t* test was used for comparison; [b] The Mann-Whitney *U* test was used for comparison; [c] The χ^2 test was used for comparison.

Yim. Transumbilical single-port access vs total laparoscopic hysterectomy. Am J Obstet Gynecol 2010.

TABLE 3
Comparison of postoperative pain between SPA-TLH and conventional TLH (n = 157)

Postoperative time	Postoperative pain score, mean (SD)		
	SPA-TLH (n = 52)	Conventional TLH (n = 105)	*P* value[a]
Immediate postoperative	3.5 (1.2)	4.5 (1.7)	< .001
6 h	3.2 (1.0)	3.6 (1.2)	.080
24 h	2.6 (0.6)	2.9 (1.2)	.052
48 h	2.2 (0.8)	2.3 (1.0)	.872

SPA-TLH, single-port access total laparoscopic hysterectomy; *TLH*, total laparoscopic hysterectomy.

[a] The Student *t* test was used for comparison.

Yim. Transumbilical single-port access vs total laparoscopic hysterectomy. Am J Obstet Gynecol 2010.

proximity of the instruments to each other.

Laparoscopic repair was planned for all patients, but this procedure was time consuming until the surgeon overcame the learning curve. In 14 patients with pelvic relaxation and enough vaginal space, the vaginal cuff was closed transvaginally; however, a transvaginal approach is difficult in patients with a deep and narrow vaginal canal. Laparoscopic sutures may become easier to perform with increasing surgeon experience and with advances in articulated single-port instruments.

The limitations of this study were that the results were based on retrospective data from review of medical records. Another limitation is the possible measurement bias from assessing 2 cohorts of consecutive patients despite the initial learning curve caused by the new single-port surgical technique. Also, objective assessment for cosmetic results and quality of life in patients who underwent SPA-TLH will be needed in the future.

In conclusion, SPA-TLH is a feasible method for hysterectomy in selected cases with better surgical outcomes and comparable postoperative pain scores when compared with conventional TLH. Further randomized prospective studies are needed to fully evaluate the benefits of this minimally invasive surgery. ■

REFERENCES

1. Johnson N, Barlow D, Lethaby A, Tavender E, Curr E, Garry R. Surgical approach to hysterectomy for benign gynaecological disease. Cochrane Database Syst Rev 2006:CD003677.

2. Kluivers KB, Johnson NP, Chien P, Vierhout ME, Bongers M, Mol BW. Comparison of laparoscopic and abdominal hysterectomy in terms of quality of life: a systematic review. Eur J Obstet Gynecol Reprod Biol 2008;136:3-8.

3. Ribeiro SC, Ribeiro RM, Santos NC, Pinotti JA. A randomized study of total abdominal, vaginal and laparoscopic hysterectomy. Int J Gynaecol Obstet 2003;83:37-43.

4. Quinones GR, Alvarado DA, Ley Ch E. [Tubal ligation using Yoon's ring]. Ginecol Obstet Mex 1976;40:127-36.

5. Pelosi MA, Pelosi MA 3rd. Laparoscopic hysterectomy with bilateral salpingo-oophorectomy using a single umbilical puncture. N Engl J Med 1991;88:721-6.

6. Pelosi MA, Pelosi MA 3rd. Laparoscopic appendectomy using a single umbilical puncture (minilaparoscopy). J Reprod Med 1992;37:588-94.

7. Ates O, Hakguder G, Olguner M, Akgur FM. Single-port laparoscopic appendectomy conducted intracorporeally with the aid of a transabdominal sling suture. J Pediatr Surg 2007;42:1071-4.

8. Kaouk JH, Haber GP, Goel RK, et al. Single-port laparoscopic surgery in urology: initial experience. Urology 2008;71:3-6.

9. Piskun G, Rajpal S. Transumbilical laparoscopic cholecystectomy utilizes no incisions outside the umbilicus. J Laparoendosc Adv Surg Tech A 1999;9:361-4.

10. Lee YY, Kim TJ, Kim CJ, et al. Single-port access laparoscopic-assisted vaginal hysterectomy: a novel method with a wound retractor and a glove. J Minim Invasive Gynecol 2009;16:450-3.

11. Bisgaard T, Klarskov B, Trap R, Kehlet H, Rosenberg J. Pain after microlaparoscopic cholecystectomy. A randomized double-blind controlled study. Surg Endosc 2000;14:340-4.

12. Leggett PL, Churchman-Winn R, Miller G. Minimizing ports to improve laparoscopic cholecystectomy. Surg Endosc 2000;14:32-6.

13. Poon CM, Chan KW, Lee DW, et al. Two-port versus four-port laparoscopic cholecystectomy. Surg Endosc 2003;17:1624-7.

14. Sarli L, Iusco D, Gobbi S, Porrini C, Ferro M, Roncoroni L. Randomized clinical trial of laparoscopic cholecystectomy performed with mini-instruments. Br J Surg 2003;90:1345-8.

15. Ros A, Nilsson E. Abdominal pain and patient overall and cosmetic satisfaction one year after cholecystectomy: outcome of a randomized trial comparing laparoscopic and minilaparotomy cholecystectomy. Scand J Gastroenterol 2004;39:773-7.

16. Sarli L, Costi R, Sansebastiano G. Mini-laparoscopic cholecystectomy vs laparoscopic cholecystectomy. Surg Endosc 2001;15:614-8.

17. Hagen ME, Wagner OJ, Christen D, Morel P. Cosmetic issues of abdominal surgery: results of an enquiry into possible grounds for a natural orifice transluminal endoscopic surgery (NOTES) approach. Endoscopy 2008;40:581-3.