Original Article

The Comparison of Outcomes between the "Skeleton Uterus Technique" and Conventional Techniques in Laparoscopic Hysterectomies

Adnan Orhan[1]*, Isil Kasapoglu[1], Gokhan Ocakoglu[2], Oguzhan Yuruk[1], Gurkan Uncu[1], Kemal Ozerkan[1]

Departments of [1]Obstetrics and Gynecology and [2]Biostatistics, Uludag University Teaching Hospital, Bursa, Turkey

Abstract

Aim: The aim of this study is to compare demographic characteristics, operative data, and complication rates of women who underwent total laparoscopic hysterectomy by the skeleton uterus technique (Skeleton-TLH) with those of women who underwent TLH by the standard technique (Standard-TLH) in a university teaching and research hospital.

Materials and Methods: This retrospective study included 932 laparoscopic hysterectomies in a university teaching and research hospital between January 1, 2013 and December 31, 2017. Clinical characteristics, operative outcomes, and complications were recorded and compared for the two techniques.

Results: In total, 932 laparoscopic hysterectomies were performed, 454 by Skeleton-TLH and 478 by Standard-TLH. The general demographic characteristics of the patients were similar; only gravida and parity were statistically significantly different between the groups ($P < 0.001$). Based on the primary outcomes (the operative data), total anesthesia time and main operation time were similar in the two groups. Estimated blood loss was statistically significantly lower in the Skeleton-TLH group than in the Standard-TLH group. Hospital stay was longer for the Skeleton-TLH group, and specimen weight was heavier. The secondary outcome was the complication rate. There were no differences between the Skeleton-TLH and Standard-TLH groups in the rates of all minor and major complications.

Conclusion: TLH with the skeleton uterus technique is feasible and safe, especially for advanced pelvic surgeons. This technique not only provides retroperitoneal access to the pelvic spaces and good anatomical visibility; but it also delivers a safer laparoscopic hysterectomy by clamping the uterine arteries and monitoring the ureter throughout the operation.

Keywords: Laparoscopic hysterectomy, minimally invasive techniques, Skeleton uterus technique

Introduction

In the past two decades, minimally invasive procedures have become extremely popular in all branches of surgery worldwide. This is also true of hysterectomy, which is the most common procedure in gynecological surgery.[1] Since laparoscopic hysterectomy was first performed in 1989, its use has been increasing steadily.[2] In the United States, laparoscopic hysterectomy rates have been around 20%.[3] The advantages of laparoscopic hysterectomy over abdominal hysterectomies include shorter hospital stay, faster recovery from surgical trauma, faster return to daily routine, and excellent cosmetic results.[4,5] There are no specific indications for laparoscopic hysterectomy compared to other surgical approaches to the hysterectomy, but these advantages indicate that minimally invasive procedures

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Address for correspondence: Dr. Adnan Orhan, Department of Obstetrics and Gynecology, Uludag University Teaching Hospital, Gorukle Campus, Bursa 16039, Turkey.
E-mail: adnanorhan@uludag.edu.tr

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(robotic or laparoscopic) are superior to abdominal hysterectomy.[6]

Laparoscopic hysterectomy technique has evolved since the 1990s and has reached a level of standardization.[7] Since 2003, laparoscopic hysterectomy has been routinely performed in our clinic in a standard and safe manner. A new technique was developed in 2010 by an advanced pelvic surgeon who had already performed >1000 laparoscopic hysterectomies in our clinic. This unique laparoscopic hysterectomy technique, which we call "Skeleton uterus," consists of eight simple steps and was published in 2016 with a sample video.[8] In this technique, lateral intraperitoneal triangles (the sacred triangles) are formed by means of peritoneal dissection bilaterally without cutting the uterine ligaments, and bilateral paravesical and pararectal peritoneal spaces are prepared. The place where the ureter crosses the uterine artery is observed, and the uterine arteries are bilaterally transected from the point at which they derive from the hypogastric arteries. After pararectal, paravesical, vesicocervical, and the rectouterine/vaginal spaces are opened and dissected, all the uterine ligaments and then the cervicovaginal junction is cut. Vaginal cuff closure is performed using an absorbable suture.

The most important advantage of this hysterectomy technique is that it allows the surgeon to gain control of the retroperitoneal area. The clear visualization of the ureteric crossing of the uterine arteries, the clamping and cutting of both uterine arteries from their origins from the hypogastric artery, and the visibility of the ureters during the operation give the surgeon a deeply anatomical perspective and good visibility. This technique enables the surgeon to gain confidence for advanced laparoscopic operations such as deep infiltrating endometriosis surgery, laparoscopic sacrocolpopexy, and gynecological oncologic surgery.

The present study aims to compare 454 previously published cases of laparoscopic hysterectomy performed using Skeleton-TLH with 478 cases using the Standard-TLH in terms of general demographic characteristics, operative results, and complications.

Materials and Methods

Our institutional patient information management database in the Department of Obstetrics and Gynaecology, University of Uludag, Bursa, Turkey was retrospectively scanned to identify all consecutive total laparoscopic hysterectomy (TLH) cases for benign indications between January 2010 and October 2017. This patient database system is updated daily by nurses, intern doctors, residents, assistant doctors, and clinicians. It contains details of patients admitted to our clinic, including their demographic characteristics, preoperative findings, operation details, postoperative follow-up data, and complications. Although this study is a retrospective analysis and each of our patient's signs a written informed consent form before hospitalization, we obtained approval from the Institutional Ethical Committee Approval (2018-1/34).

All patients underwent a routine pelvic examination and preoperative evaluation, including a Papanicolaou smear test, transvaginal ultrasound, and other system physical examinations before surgery. Nonsurgical alternatives, such as ulipristal acetate for myoma uteri, were discussed and offered as an option to the patients.[9] Exclusion criteria were gynecologic or other system malignancies, suspicious uterine or adnexal masses and laparoscopic hysterectomy contraindications such as sarcoma suspicion or huge pelvic masses. Inclusion criteria were total laparoscopic hysterectomies for benign gynecologic indications.

The operations were performed under general anesthesia in the dorsal lithotomy position. Antibiotic prophylaxis of cefazolin was administered 1 h before surgery, and antithrombotic prophylaxis was given according to the guidelines of the American College of Obstetricians and Gynecologists.[10]

Skeleton-TLH operations (n = 454) were performed by one surgeon (KO), a laparoscopic pelvic surgeon who holds a master's degree from the European Academy of Gynaecological Surgery.[11] This surgeon performed >1000 total laparoscopic hysterectomies before using the skeleton technique. The details of this laparoscopic hysterectomy technique have been published together with an edited operational video. The eight primary steps may be summarized as follows: step 1, definition of anatomic landmarks; Step 2, the sacred triangle; Step 3, uterine artery transection; Step 4, vesicocervical space dissection; Step 5, rectouterine/rectovaginal space dissection; Step 6, cutting the uterine ligaments; Step 7, vaginal entry; and Step 8, cuff suturing.[8]

Standard-TLH operations (n = 478) were performed by other academic staff (at Associate Professor or Professor level) in our department (GU, MA, AO, and IK). Each of these surgeons hold a certificate in advanced level laparoscopic pelvic surgery from the Minimally Invasive Gynecologic Association of Turkey and had performed >1200 total laparoscopic hysterectomies before this study. The surgeons include the president and a board member of the Minimally Invasive Gynecologic Association of Turkey, and they have given live masterclass laparoscopic surgery sessions in Turkey and around the world.[12,13] Standard-TLH operation technique is defined as in the study of Einarsson.[7]

The two groups of patients (the Skeleton-TLH group and the Standard-TLH group) were compared in terms of

general demographic characteristics, intraoperative data, and complications (reoperation, conversion to laparotomy, and minor and major complications).

Total anesthesia time (h) was defined as the time from the first propofol injection to the departure time from the operation room. The main operative time (h) was recorded from the first trocar insertion to the last trocar closure. Estimated blood loss was calculated from the contents of the aspiration/suction devices. The duration of hospital stays (measured in hours) were counted from the time of hospitalization to the time of discharge. Total complications were divided into minor and major complication groups as in the eVALuate and FINHYST studies.[14,15] Minor complications were defined as minor hematoma, fever ≥38°C, urine retention, urinary tract infection, ileus, deep vein thrombosis, readmission, minor anesthesia problems, stump problems (cuff dehiscence or prolapse), trocar site problems (infection, bleeding, or hernia) and representation with bleeding or pain. Major complications were defined as reoperation, major hemorrhage requiring transfusion, hematoma requiring transfusion/drainage, bowel injury, ureteric injury, bladder injury, major anesthesia problems or intensive care unit admission, pulmonary thromboembolism, and conversion to laparotomy. The patients were evaluated in a postoperative visit 1 month after surgery and were contacted by phone or E-mail in case of inadequate follow-up.

Statistical analysis

A Shapiro–Wilk test was used to assess whether the variables followed a normal distribution. Continuous variables were reported as mean ± standard deviation and median (minimum: maximum) values. According to the normality test results, independent sample *t* or Mann–Whitney U tests were used to compare the groups. Categorical variables were compared by the Chi-square and Fisher's exact tests. Evaluation of the data was done using IBM SPSS 21.0 (IBM Corp. IBM SPSS Statistics for Windows, Version 21.0, Armonk, NY, USA). Statistical significance was defined as $P < 0.05$.

Results

During the study a total of 932 patients underwent TLH for benign gynecologic indications. Of these laparoscopic hysterectomies, 454 were performed using the Skeleton-TLH technique, and 478 were performed using the Standard-TLH technique. The TLH indications of the patients in the two groups are given in Table 1. Indications for hysterectomy were heavy menstrual bleeding (161 cases [35.5%] in the Skeleton-TLH group and 169 cases [35.4%] in the Standard-TLH group), myoma uteri (153 [33.7%] and 158 [33.1%]), endometrial hyperplasia (43 [9.5%] and 48 [10.0%]), endometriosis or chronic pelvic pain (38 [8.4%] and 40 [8.4%]), adnexal mass (35 [7.7%] and 38 [7.9%]), preinvasive cervical lesions (21 [4.6%] and 22 [4.6%]), pelvic organ prolapse (POP) (2 [0.4%] and 1 [0.2%]) and other indications (1 [0.2%] and 2 [0.4%]).

The demographic characteristics of the patients are given in Table 2. There were no differences between the two groups in terms of age, BMI, current smoking, prior cesarean section, previous pelvic surgery, menopausal status, or hormone therapy. Gravida and parity were statistically significantly lower in the Skeleton-TLH group than in the Standard-TLH group (3.0 [3.16 ± 1.654] and 4.0 [3.68 ± 1.211] and

Table 1: Total laparoscopic hysterectomy indications of the patients

Indications	Skeleton-TLH (*n*=454), *n* (%)	Standard-TLH (*n*=478), *n* (%)
Heavy menstrual bleeding	161 (35.5)	169 (35.4)
Myoma uteri	153 (33.7)	158 (33.1)
Endometrial hyperplasia	43 (9.5)	48 (10.0)
Endometriosis or chronic pelvic pain	38 (8.4)	40 (8.4)
Adnexal mass	35 (7.7)	38 (7.9)
Preinvasive cervical lesions	21 (4.6)	22 (4.6)
POP	2 (0.4)	1 (0.2)
Other	1 (0.2)	2 (0.4)
Total	454 (100)	478 (100)

Data are presented as, *n* (%). POP: Pelvic organ prolapse, TLH: Total laparoscopic hysterectomy

Table 2: Demographic characteristics of the patients according to the surgical technique

	Skeleton-TLH (*n*=454), *n* (%)	Standard-TLH (*n*=478), *n* (%)	*P*
Age (years)	51.69±8.927 (32:83)	52.47±4.488 (42:71)	0.459[a]
BMI (kg/m^2)	27.94±1.076 (20:36)	28.05±0.805 (25:31)	0.062[a]
Gravida	3.0 (0:11) 3.16±1.654	4.0 (0:9) 3.68±1.211	<0.001[b]
Parity	2.0 (0:7) 2.43±1.181	3.0 (0:5) 2.87±1.028	<0.001[b]
Current smoker (>15/day)	125 (27.5)	134 (28)	0.865[c]
Prior C/S (≥1)	110 (24.2)	121 (25.3)	0.701[c]
Previous pelvic surgery (≥1)	115 (25.3)	123 (25.7)	0.888[c]
Menopausal status	201 (44.3)	231 (48.3)	0.215[c]
Hormone therapy	19 (4.2)	22 (4.6)	0.756[c]
Race			
White	436 (96)	455 (95.2)	N/A
Caucasian	15 (3.3)	18 (3.8)	N/A
Arabian	3 (0.7)	4 (0.8)	N/A
Black	0 (0.0)	1 (0.2)	N/A

Data are presented as mean±SD, median (minimum: maximum) or *n* (%). [a]Independent samples *t*-test, [b]Mann–Whitney U-test, [c]Pearson Chi-square test. N/A: Not applicable, C/S: Cesarean section, BMI: Body mass index, TLH: Total laparoscopic hysterectomy, SD: Standard deviation

2.0 [2.43 ± 1.181] and 3.0 [2.87 ± 1.028]), respectively. In the Skeleton-TLH group, 436 patients were Turkish (96%), 15 were Caucasian (3.3%), and three patients were Arabian (0.7%). In the Standard-TLH group, 455 patients were White (95.2%), 18 were Caucasian (3.8%), 4 were Arabian (0.8%) and one was African (0.2%).

The primary outcomes were the patient operative data, as shown in Table 3. Total anesthesia time and main operation time were similar between the groups. Estimated blood loss was statistically significantly lower in the Skeleton-TLH group than in the Standard-TLH group (91.63 ± 47.18 ml and 127.93 ± 43.46 ml, respectively). Mean hospital stay was statistically significantly longer in the Skeleton-TLH group than in the Standard-TLH group (32.36 h ± 5.161 and 29.76 h ± 1.131). Specimen weight was statistically significantly heavier in the Skeleton-TLH group than in the Standard-TLH group (132.51 g ± 59.951 and 125.57 g ± 57.832).

Table 3: Operative data of the patients according to the surgical technique

	Skeleton-TLH (*n*=454)	Standard-TLH (*n*=478)	*P*
Total anesthesia time (min)	93.0 (42:510) 96.63±27.976	93.0 (70:400) 100.98±24.931	0.013[b]
Main operation time (min)	80.0 (50:140) 78.21±11.233	80.0 (60:140) 81.48±19.591	0.383[b]
Estimated blood loss (mL)	90 (20:480) 91.63±47.18	130 (30:560) 127.93±43.46	<0.001[b]
Hospital stay (h)	30.0 (26:50) 32.36±5.161	30.0 (20:30) 29.76±1.131	<0.001[b]
Specimen weight (g)	130 (65:523) 132.51±59.951	123 (60:523) 125.57±57.832	<0.001[b]

Data are presented as median (minimum: maximum), mean±SD. [b]Mann–Whitney U-test, SD: Standard deviation, TLH: Total laparoscopic hysterectomy

Complications were evaluated as secondary outcomes. All the TLH complications in the two groups are shown in Table 4. There was no statistically significant difference between the two groups in terms of total complications or in subgroups of total minor complications and major complications. One case of hematoma requiring transfusion and drainage was observed in the Skeleton-TLH group, but there were none in the Standard-TLH group. Although ileus complication was observed only once in each group, this was statistically significant because of the number of cases in each group.

Discussion

The present study reveals that in tertiary centers and inexperienced hands, laparoscopic hysterectomy can be safely and successfully

Table 4: Total laparoscopic hysterectomy complications of the two groups

	Skeleton-TLH (*n*=454), *n* (%)	Standard-TLH (*n*=478), *n* (%)	*P*
Major complications			
Reoperation, *n* (%)	2 (0.4)	3 (0.6)	0.978[d]
Major hemorrhage requiring transfusion	6 (1.3)	4 (0.8)	0.537[d]
Hematoma requiring transfusion/drainage	1 (0.2)	1 (0.2)	0.868[d]
Bowel injury	2 (0.4)	3 (0.6)	0.856[d]
Ureteric ınjury	1 (0.2)	3 (0.6)	0.625[d]
Bladder ınjury	5 (1.1)	6 (1.2)	0.537[d]
Major anesthesia problems (ICU admission)	1 (0.2)	1 (0.2)	0.968[d]
Pulmonary thromboembolism	1 (0.2)	2 (0.4)	0.679[d]
Conversion to laparotomy	3 (0.7)	4 (0.8)	0.876[d]
Total major complications	22/454 (4.80)	27/478 (5.60)	0.583[c]
Mınor complıcatıons			
Hematoma not requiring transfusion (minor hematoma)	6 (1.3)	7 (1.5)	0.853[c]
Fever	10 (2.2)	9 (1.9)	0.730[c]
Urine retention	3 (0.7)	2 (0.4)	0.679[d]
UTI	8 (1.8)	9 (1.9)	0.891[c]
Ileus	1 (0.2)	1 (0.2)	<0.001[d]
Deep vein thrombosis	4 (0.9)	3 (0.6)	0.719[d]
Readmission	4 (0.9)	5 (1.0)	0.648[d]
Minor anesthesia problems	8 (1.8)	9 (1.9)	0.891[c]
Stump problems (cuff dehissence or prolapse)	4 (0.9)	5 (1.0)	0.846[c]
Trocar site problems (ınfection, bleeding, or hernia)	7 (1.5)	6 (1.2)	0.709[c]
Represent with bleeding or pain	6 (1.3)	7 (1.5)	0.853[c]
Total minor complications	61/454 (13.43)	63/478 (13.17)	0.908[c]
Total complıcatıons	83/454 (18.30)	90/478 (18.80)	0.830[c]

Data are presented as, *n* (%). [c]Pearson Chi-square test, [d]Fisher's exact test. ICU: Intensive care unit admission, UTI: Urinary tract ınfection, TLH: Total laparoscopic hysterectomy

performed using the Skeleton-TLH technique. There was a significant difference in terms of blood loss between the laparoscopic hysterectomies performed with the skeleton uterus technique and those with the standard technique. In the standard laparoscopic hysterectomy using retroperitoneal dissection, the ureter and the major vessels are clearly demonstrated in such a way that the pelvic anatomy dominance and competence of the surgeon further increases. We value this technique for laparoscopic surgeons who are considering improving their laparoscopic skills and for those who want to learn the anatomy of pelvic peritoneal spaces in depth.

The main purpose for laparoscopic hysterectomies performed with the skeleton uterus technique is peritoneal dissection. In this dissection, starting from the bottom of the round ligaments, the sacred triangle is entered, and the pararectal and the paravesical pelvic spaces are prepared. This technique gives the surgeon two advantages. The first and most important advantage is that less blood loss occurs because the uterine arteries are clamped and cut bilaterally where they originate from the internal iliac arteries. In this study, the estimated blood loss in the skeleton uterus group was 36 ml less than in the Standard-TLH group. Many previous studies have shown that clamping the uterine arteries during laparoscopic hysterectomy results in less blood loss.[16] In one study, total blood loss in early uterine artery ligation group was found to be 10 ml less than that of the Standard-TLH group (50 vs. 60 ml).[17] The second advantage is that the location where the ureter crosses the uterine artery is clearly visible in the skeleton uterus technique. The peritoneal dissection allows the ureter to be seen easily on both sides throughout the operation; ureteric complications are, therefore, less frequent. We observed that ureter complications in standard hysterectomies were three times higher than with the skeleton uterus technique (three cases compared to one). Although ureteric complications were seen less frequently in the Skeleton-TLH group than in the Standard-TLH group, this difference did not reach statistical significance. We believe, however, that if the number of samples was high enough, the rate of ureteric complications would be statistically lower in the skeleton uterus group. The complications in laparoscopic hysterectomy that are most common and that cause gynecologists most concern are urinary tract complications.[18-20] The most important advantage of the skeleton uterus technique is that it can solve the most problematic part of the laparoscopic hysterectomy. When performing a laparoscopic hysterectomy with the skeleton uterus technique, the ureter is always in the surgeon's field of vision, and the complication rate is, therefore, extremely low. The minimal rate of complications of the ureter proves that the Skeleton-TLH technique is reliable, despite the dissection of all pelvic spaces that it involves.

In terms of the data that we found to be statistically significant, we believe that two items are unlikely to make a clinically meaningful difference. First, the duration of hospitalization in the operative data was only 3 h longer in the Skeleton-TLH group than in the Standard-TLH group (32.36 ± 5.161 h and 29.76 ± 1.131 h, respectively), which has no impact on patient outcomes. Similarly, the mean specimen weight was only 7 g heavier in the Skeleton-TLH group than in the Standard-TLH group. We believe that this small weight difference between the groups is only a statistical result; however, the greater weight of specimens in the Skeleton-TLH group can be taken as a point in favor of the skeleton uterus technique. Although there was no difference between the groups in terms of total minor and major complications, a statistically significant difference in the rate of ileus complication was found (although it was observed only once in each group). We think that this statistical difference is unlikely to have any clinical significance.

As the level of familiarity with laparoscopic surgery has increased, difficult laparoscopic operations performed with different techniques have become popular, particularly in the past decade.[21-23] If the choice of technique can really make a substantial difference in patient outcomes, then every available technique is worth considering.[24] The benefits offered by a new laparoscopic technique are important not only in terms of operative and complication data but also in terms of the increased visibility available to the laparoscopic pelvic surgeon. The endoscopic surgery adventure started with a small umbilical hole, but frequent progress in different laparoscopic techniques has brought us to a point where there is almost no gynecological surgery that cannot be done laparoscopically.

The most important limitation of this study is the retrospective design of the analysis. We, therefore, tried to minimize reporting bias, underestimation of possible adverse events and overestimation of possible good results. In addition, we tried to limit the risk of bias with the systematic design of the hospital patient database.

Another limitation is that the skeleton uterus technique may be particularly difficult for surgeons, even for those with basic laparoscopic experience. The surgeon who created this technique developed it after performing approximately 1000 laparoscopic hysterectomies. Our goal is not to perform every laparoscopic hysterectomy using this technique. We aim to provide a broad range of options within advanced laparoscopic pelvic surgery and to select a safe and effective technique for each case.

Another limitation of this study is its similarity to extrafascial hysterectomy. In the case of peritoneal dissection, two surgical techniques are similar. However, no ligaments are cut

until the vaginal entry stage in the skeleton uterus technique. We think that the skeleton uterus technique provides a special anatomical perspective from a different point of view.

Conclusion

It is possible to perform laparoscopic hysterectomies from a different anatomical perspective and from a different and deep point of view. Although it may initially seem difficult and time-consuming, laparoscopic hysterectomy can be carried out safely and effectively using the skeleton uterus technique. The availability of such different surgical techniques and deep anatomical perspectives may increase laparoscopic surgical skills, especially among surgeons dealing with advanced laparoscopic surgery and among surgeons at any level who are interested in endoscopic surgery.

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Conflicts of interest

There are no conflicts of interest.

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