ORIGINAL RESEARCH

Total Laparoscopic Hysterectomy: Body Mass Index and Outcomes

Katherine A. O'Hanlan, MD, Lisbeth Lopez, Suzanne L. Dibble, DNSc, RN, Anne-Caroline Garnier, Gloria Shining Huang, MD, and Mirjam Leuchtenberger

OBJECTIVE: This retrospective review of patients undergoing total laparoscopic hysterectomy examines whether differences in outcomes exist on the basis of body mass index (BMI).

METHODS: All cases of total laparoscopic hysterectomy performed from September 1996 to July 2002 for benign diagnoses, and microinvasive cervical, early endometrial, and occult ovarian carcinoma were reviewed. There were 330 patients analyzed by BMI category (range, 18.5–54.1): ideal (n = 150) less than 24.9 kg/m^2, overweight (n = 95) 25 to 29.9 kg/m^2, and obese (n = 78) 30 kg/m^2 or more. Seven patients were converted to laparotomy (four ideal BMI, two overweight, one obese) leaving 323 (98%) for analysis. Mean age (50 years), height (65 in.), and parity (1.2) were similar, with 39% nulligravidas in each group.

RESULTS: Mean operating time (156 minutes), blood loss (160 mL), and length of hospital stay (1.9 days) did not vary by BMI group. Total complication rates (8.9%), and major (5.5%) and minor (3.4%) complication rates were similar in each BMI group. Urologic injury was observed in 3.1%, with two-thirds occurring in the first one-third of the patient series.

CONCLUSION: Total laparoscopic hysterectomy is feasible and safe, resulting in short hospital stay, minimal blood loss, and minimal operating time for patients in all BMI groups. The laparoscopic approach may extend the benefits of minimally invasive hysterectomy to the very obese, for whom abdominal surgery poses serious risk. (Obstet Gynecol 2003;102:1384–92. © 2003 by The American College of Obstetricians and Gynecologists.)

Laparoscopic approaches for indicated surgery have been shown to reduce duration of hospital stay and postoperative disability. High body mass index (BMI) was originally seen as a relative contraindication for advanced laparoscopic procedures, but this has recently come under review.[1] Because high BMI is a known risk factor for pelvic floor disorders, menometrorrhagia, adenomyosis, fibroids, endometrial hyperplasia, and endometrial carcinoma, many women with high BMI will require hysterectomy. In addition, other gynecologic malignancies such as ovarian and cervical carcinoma, and many benign conditions such as fibroids, pelvic pain, and prolapse occur among women of all BMIs[2,3] and may also require hysterectomy. Many of these gynecologic conditions in obese patients were traditionally managed by total abdominal hysterectomy (TAH) via open laparotomy with a higher rate of complications such as wound infection, pelvic abscess, and dehiscence than observed in nonobese patients.[4] Now, with improved instrumentation and techniques, many advanced laparoscopic procedures have been observed to be safe and feasible in women with high BMI.[5,6] In randomized trials comparing TAH with laparoscopic-assisted vaginal hysterectomy (LAVH) for benign indications, similar overall complications, less blood loss, longer operating times, fewer transfusions, less pain, and shorter hospital stay and disability were observed with the endoscopic procedure.[7–11] However, LAVH is predicated on the ability to perform the dissection of the cervix and lower uterine segment through the vagina. Nulliparous women are at increased risk of developing uterine carcinoma,[12] and many will not qualify for the LAVH because many may lack sufficient uterine prolapse and vaginal capacity.

A promising alternative to LAVH and TAH is the total laparoscopic hysterectomy, which is entirely performed through the abdominal trochars, with the disconnected uterus and tissues simply passed out through the vagina or morcellated via trochar.[13,14] Shorter operating times, less blood loss, and shorter hospital stays have been observed in studies comparing total laparoscopic hysterectomy with LAVH.[15–17] A totally laparoscopic approach has been reported in a series of 11 morbidly obese women with no complications being reported, but a longer operating time was observed.[18] Before recommending randomized clinical trials comparing TAH or LAVH with total laparoscopic hysterectomy, a larger

From Gynecologic Oncology Associates, Stanford University School of Medicine, University of California, School of Nursing, Duke University School of Medicine, Albert Einstein College of Medicine, Division of Gynecologic Oncology, and Ruprecht-Karls-Universitat Heidelberg, Germany.

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observational cohort feasibility series is needed focusing on outcomes as they relate to BMI.

In this retrospective report, the patient demographics, preoperative indications, surgical data, and complications are recorded from 5.8 years in a single surgeon's teaching practice, and are analyzed to describe surgical and pathological parameters of performing a total laparoscopic hysterectomy analyzed by BMI categories. The main outcomes were number of complications, duration of surgery, duration of hospital stay, and amount of blood loss.

MATERIALS AND METHODS

Body mass index was calculated by dividing a person's weight in kilograms by the square of their height in meters. Ideal BMI has been defined as between 18.5 to 24.9 kg/m^2, overweight is having a BMI between 25 to 29.9 kg/m^2, and obese patients are those with a BMI of 30 kg/m^2 or more.[19] Included for analysis are all cases of simple total laparoscopic hysterectomy performed for benign gynecologic indications, microinvasive cervical cancer, occult ovarian cancer, and clinical stage IIA or less endometrial cancer performed by a single surgeon over a period from September 1996 to July 2002, at four San Francisco Bay area hospitals. All surgeries were teaching cases, assisted by a categoric obstetrics and gynecology resident or, less often, by an attending physician who specialized in obstetrics and gynecology who was also actively learning the technique. Investigational review board approval was not requested for this anonymous, retrospective, data abstraction and analysis project.

All patients needing hysterectomy in this practice were scheduled for a total laparoscopic hysterectomy unless they had previous surgical reports documenting severe abdominal adhesions/intestinal adhesions, clinical or radiographic evidence of metastatic ovarian carcinoma or endometrial carcinoma, or documented significant cardiopulmonary disease. Cardiopulmonary disease was defined as any history of cardiac failure, myocardial infarction, unstable angina, or moderate pulmonary obstructive disease considered poorly controlled or contraindicating prolonged steep Trendelenburg position. Because patients who have undergone open laparotomy are not comparable in health history or health status to those who undergo a laparoscopic approach, they are not included for comparison; rather, only patients who underwent total laparoscopic hysterectomy were analyzed for differences. No obese patients were refused a laparoscopic approach for cardiopulmonary comorbidities, diabetes, senior age, or illness. In this practice, it is estimated that about one half of patients are in the ideal BMI category, and one fourth were each in the overweight and obese categories. No patient was refused a laparoscopic approach for her hysterectomy on the basis of BMI.

Total laparoscopic hysterectomy means all surgery was performed entirely through the laparoscopic ports, including the closure of the vagina.[20] Because this is a relatively new application of surgical technique in gynecology and gynecologic oncology, the specific steps will be delineated. The patient is positioned in a modified lithotomy position with the hips at about 180° extension and the knees flexed at nearly 90° with the table tilted nearly 45° Trendelenburg. The arms are tucked along the patient's side and secured in a sled, and gel bolsters were taped above the shoulders to prevent upward drifting on the table. All patients had general anesthesia and received standard prophylactic cephalosporin antibiotic, a subcutaneous injection of an antithrombin agent, and wore thromboembolic preventive hoses and sequential compression devices; all had an upper body warmed-air circulating body warmer. A 5-mm EndoEthicon (Ethicon Endo-Surgery, Cincinnati, OH) trochar is used with a bladed 90° direct central intraumbilical entry without preinsufflation by elevating the abdominal wall with a single arm of two towel clips passed into the umbilical incision.[21] In most cases, three additional 5-mm ports are inserted under direct visualization, one suprapubic and two just medial and superior to the anterior superior iliac crests.

The cytologic washing, if indicated, is obtained before manipulating the tissues for abdominal inspection. All adhesions are lysed, and any peritoneal lesions undergo biopsy or are excised before hysterectomy. Once the ureters are identified at the pelvic brim, the infundibulopelvic or uteroovarian ligaments, broad, and round ligaments are cauterized and incised with the 5-mm LCS harmonic scalpel (Ethicon Endo-Surgery).[22] To replicate the effects of "traction–countertraction," before parametrial dissection, the uterus is placed under tense axial elevation by pushing the uterine manipulator directly cephalad. Then a bladder flap is incised with the Harmonic scalpel exposing the anterior cervical fascia. The uterine arteries are skeletonized and extensively cauterized at the junction of the lower and middle third of the cervical body by using the bipolar cautery, and incised with the Harmonic scalpel directly through to the cervical fascia beneath. The arterial pedicle is pushed inferiorly exposing the cardinal ligament fibers. These are incised in three bundles: first anteriorly, then posteriorly to include the uterosacral ligament, and finally medially and inferiorly, staying on the cervical fascial surface. This last incision usually identifies the exact edge of the cervicovaginal margin and allows for the next medial

Table 1. Patient Demographics Stratified by Body Mass Index Category

Demographic	Ideal (n = 150)	Overweight (n = 95)	Obese (n = 78)	P *
Age (y)	50.4 (9.8)	50.4 (11.7)	48.7 (10.4)	.451
Parity	1.2 (1.2)	1.3 (1.3)	1.3 (1.4)	.600
Height (in)	64.9 (2.4)	64.5 (2.9)	64.2 (2.9)	.120
Weight (lb)	134.9 (13.9)	158.9 (17.0)	214.6 (39.7)	<.001†
BMI (kg/m^2)	22.5 (1.6)	26.9 (1.4)	36.7 (6.4)	<.001†

BMI = body mass index.

Values are presented as mean (standard deviation).

* Analysis of variance.

† All three categories significantly different from each other by multiple specific comparisons.

bite to pierce into the vagina at either 9:00 or 3:00. The anatomy is repeatedly confirmed by using instrument palpation of the firmer cervix stroma, which moves together as a solid mass, compared with the more pliant upper lateral vagina, which dimples easily. Also, the surface of the cervix anteriorly and posteriorly are frequently visualized and palpated with the instruments. If there is difficulty identifying the precise cervicovaginal margin, a right angle retractor or ribbon can be passed into the vagina anterior to the uterine manipulator to identify the junction anteriorly so that the Harmonic scalpel can by used to puncture into the vagina at 12:00.

Entry into the vagina is confirmed by rapid loss of pneumoperitoneum. The uterine manipulator is then removed and a glove containing one or two fluffed 4 × 4 in. gauze pads is placed in the vagina to reestablish and maintain the pneumoperitoneum. With direct exposure of the cervical os with toothed biopsy forceps as graspers on the vagina and the cervical edge, it is possible to expose and incise along the precise margin between cervix and vagina. Once the entire cervix is cut away from the vagina, a tenaculum is inserted through the vagina to grasp the cervix and deliver the tissue out the vagina. The uterus is submitted for frozen section, if indicated for endometrial hyperplasia, carcinoma, or sarcoma.

If node dissection was not indicated and no other procedures were indicated, the vaginal apex was closed with toothed biopsy forceps as graspers and a nonpretied #1 Vicryl laparoscopic suture with an ST-3 needle in three or more figure-of-eight (technically spiral) sutures with a Wolf or Ethicon laparoscopic needle driver, fixing the vaginal angle to the uterosacral and round ligaments for vaginal suspension.

All patients had been provided printed information about bowel preparation, inpatient postoperative recovery, and home recovery, and they were told when to call the doctor. Discharge instructions included resumption of all activities as soon as tolerated; walking and floor exercise were encouraged. All patients were initially assessed for an abdominal incision check 10 days after discharge and again at 6 weeks. Patients were instructed not to engage in any penetrating sexual activity until they received clearance to do so at their 6-week vaginal checkup.

Office and hospital charts were then reviewed for patient data regarding age, height, weight, parity, preoperative diagnosis, procedure or procedures, estimated blood loss, duration of surgery, duration of hospital stay, and pathologic data, including uterine dimensions, weight, number of nodes dissected, and complications. The main outcomes were complications, duration of surgery, duration of hospital stay, and blood loss.

The data were analyzed by Stat-View statistical software (SAS Institute, Cary, NC) using analysis of variance for comparison of continuous data, and χ^2 analyses, including the Fisher exact test for nominal data. $P < .05$ was accepted as significant.

RESULTS

Of 330 patients identified, seven patients were converted to open laparotomy, leaving 323 for this analysis. Of these, 150 had an ideal BMI, 95 were overweight, and 78 were obese. Among the seven, four with ideal BMI were converted to open laparotomy: one because cautery equipment was temporarily nonfunctional at that community hospital, one with well-differentiated endometrial cancer who had widely metastatic disease that was not identified radiographically before her surgery, one found to have a retroperitoneal 12-cm hemangiopericytoma diagnosed by ultrasound as a myoma, and one with a 14-cm cervical retroperitoneal myoma. Two overweight patients were converted: Both had a uterus of more than 900 g and isthmic myomas, which precluded hemostatic access to the uterine arteries. One obese patient was converted who had a 12-cm vascular, solid, and cystic ovarian mass, which could not fit into the available morcellation bag for intact removal.

Table 2. Patient Diagnoses Stratified by Body Mass Index Category

Diagnosis	Ideal (n = 150)	Overweight (n = 95)	Obese (n = 78)	P*
Preoperative diagnosis				
Pelvic mass	32 (21.3)	21 (22.1)	15 (19.2)	.226
Pelvic pain	19 (12.7)	11 (11.6)	8 (10.3)	.292
Adenomyosis	4 (2.7)	2 (2.1)	3 (3.8)	.494
Incontinence/prolapse	3 (3.3)	3 (3.2)	2 (2.6)	.326
Vaginal cancer	1 (.7)	0	0	.561
Cervical dysplasia	4 (2.7)	1 (1.1)	3 (3.8)	.490
Endometrial hyperplasia	5 (3.3)	2 (2.1)	2 (2.6)	.842
Endometrial cancer/sarcoma	15 (10.0)	10 (10.5)	16 (20.5)	.058
Leiomyoma	51 (34.0)	40 (42.1)	28 (35.9)	.431
Ovarian cancer	3 (2.0)	2 (2.1)	0	.445
Familial breast/Ovarian cancer	12 (8.0)	3 (3.2)	1 (1.3)	.054
Cervical carcinoma	1 (.7)	0	0	.561
Postoperative diagnosis				
No pathologic diagnosis	21 (14)	11 (11.6)	7 (8.9)	.535
Benign ovarian lesions	20 (13.3)	10 (10.5)	13 (16.7)	.497
Cervical dysplasia	4 (2.7)	1 (1.1)	3 (3.8)	.490
Leiomyoma	55 (36.7)	50 (52.6)	28 (35.9)	.026
Adenomyosis	11 (7.3)	9 (9.5)	6 (7.7)	.828
Endometrial hyperplasia	4 (2.7)	3 (3.2)	4 (5.1)	.616
Endometrial cancer/sarcoma	16 (10.6)	6 (6.3)	13 (16.7)	.093
Ovarian and endometrial cancer	0	1 (1.3)	0	.561
Ovarian cancer	4 (2.7)	3 (3.2)	0	.310
Endometriosis	12 (8.0)	1 (1.1)	4 (5.1)	.099
Abscess	1 (.7)	0	0	.561
Vaginal cancer	1 (.7)	0	0	.561
Breast cancer	1 (.7)	0	0	.561

Values are presented as n (%).
* χ^2 analysis.

There were no significant differences in age, height, or parity among the three BMI groups (Table 1). Although the mean age was 50 years, patients' ages ranged from 24 to 85 years (P = .451), and parity was 1.2 (range, 0–7; P = .600). Overall, 39% of the women in each of the three groups were nulligravid.

Clinical parameters including the clinical indications for the surgeries and the final pathologic diagnosis can be found in Table 2. The more common gynecologic entities were observed including leiomyomata uteri, pelvic pain, pelvic mass, cervical dysplasia, incontinence, prolapse (symptomatic or massive), and adenomyosis. Oncologic indications for hysterectomy included many with endometrial hyperplasia, early-stage endometrial carcinoma, and occult or apparent stage I ovarian carcinoma. One patient with a small, recently resected, unstaged, invasive vaginal carcinoma at the midlevel of the vagina also had hysterectomy for menorrhagia with a laparoscopic pelvic lymph node dissection and open dissection of the groin. Although 16 women had familial breast/ovarian cancer pedigrees, including many with *BrCa* 1 or 2 mutation positivity, only one had pathologic findings of a recurrent breast cancer on her ovaries.

There were no statistically or clinically significant differences in the number of complications, duration of surgery, volume of blood loss, or duration of hospital stay among the three BMI groups (Table 3). However, the β error rate for these analyses was more than the 20%

Table 3. Surgical Data Stratified by Body Mass Index Category

Surgical data	Ideal (n = 150)	Overweight (n = 95)	Obese (n = 78)	P
Duration of surgery (min)	153.7 (48.7)	152.2 (56.5)	164.9 (42.32)	.185*
Estimated blood loss (mL)	153.5 (196.7)	159.4 (196.0)	167.8 (199.7)	.873*
Length of hospital stay (d)	1.8 (1.2)	1.8 (1.5)	2.2 (3.6)	.403*
Total complications	16	11	2	.073†

Values are presented as mean (standard deviation)
* Analysis of variance.
† χ^2 test.

Table 4. Additional Procedures Stratified by Body Mass Index Category

Additional procedures	Ideal (n = 150)	Overweight (n = 95)	Obese (n = 78)	P*
Fulgerate endometriosis	19 (12.7)	7 (7.4)	3 (3.8)	.07
Lysis of adhesions	10 (6.7)	5 (5.3)	3 (3.8)	.67
Port removal	0	1 (1.1)	0	.300
Node dissection	11 (7.3)	5 (5.3)	5 (5.3)	.730
Omentectomy	4 (2.7)	3 (3.2)	0	.310
Burch	2 (1.3)	4 (4.2)	5 (5.3)	.695
Cystoscopy	49 (32.96)	38 (40.0)	23 (29.5)	.310
Cystotomy repair	2 (1.3)	1 (1.1)	2 (2.6)	.528
Ureterolysis	6 (4.0)	4 (4.2)	3 (3.8)	.992
Ureteral stent placement	1 (.6)	1 (1.1)	0	.313
Moscowitz, posterior repair	4 (2.7)	4 (4.2)	2 (2.6)	.756
Appendectomy	19 (12.7)	10 (10.5)	4 (5.1)	.203
Cholecystectomy	1 (.6)	1 (1.1)	2 (2.6)	.456

Data are presented as n (%).
* χ^2 test.

usually accepted. Realistically, differences of 11 minutes of surgical time, 15 mL in blood loss, or 0.4 hospital days are not clinically significant. Certainly, we would be able to make these small differences statistically significant if we were to analyze enough patients. For instance, to find a statistically significant difference among the actual means in estimated blood loss, we would have needed approximately 11,508 patients; 959 patients to assess differences in duration of surgery; and 1332 patients to study significant differences in length of hospital stay.

Although many patients had additional procedures such as fulguration of endometriosis, lysis of adhesions, port removal, cystoscopy, Burch procedure, node dissection, appendectomy, ureterolysis, and omentectomy (Table 4), the specific times required for these procedures were not subtracted from total times for the surgeries. However, most of the patients having only hysterectomy with cystoscopy required 147 minutes, and hysterectomy with no other procedure took about 134 minutes, with 24 being completed within 60 to 90 minutes. We performed many cystoscopies early in this series of patients, most often to ascertain that the ureters were generating equally strong urinary jets.

Although the mean hospital stay was 1.8 days for all 328 patients, the median hospital stay was 1.0 day for the last 130 patients undergoing total laparoscopic hysterectomy. This suggests that although a few outliers may bring up the mean, most women required only 1 day of hospitalization. A significant trend of decreasing number of days in the hospital was observed, with increasing number of cases completed. (P = .001, ANOVA).

The uterine weight and dimensions were not statistically significantly different by BMI category (Table 5). Twenty-seven women had uteruses weighing between 500 and 1000 g, and three had uteruses weighing more than 1 kg. Many women, including many nulligravidas, had vaginal morcellation of enlarged uteruses, whereas the remainder of women with no vaginal capacity had electronic morcellation of the enlarged uterus by suprapubic trochar. The adnexal size was analyzed for comparison only in the 66 patients with pelvic mass listed as the reason for the surgery, and no significant difference

Table 5. Pathologic Data Analyzed by Body Mass Index Category

Pathologic data	Ideal (n = 150)	Overweight (n = 95)	Obese (n = 78)	P*
Pathology of uterus†				
Length (cm)	9.8 (3.3)	10.6 (3.9)	10.2 (3.3)	.097
Width (cm)	6.8 (2.8)	7.5 (3.2)	6.8 (2.8)	.231
Depth (cm)	4.5 (1.9)	4.8 (1.8)	4.9 (1.8)	.310
Weight (g)	205 (190)	232 (212)	259 (262)	.278
Ovarian mass (cm)‡	6.8 (3.2)	8.5 (4.4)	8.7 (5.1)	.263
No. nodes obtained§	9.4 (8.4)	13 (6.2)	10 (9.9)	.722

Data are presented as mean (standard deviation).
* Tukey/Kramer test.
† Uterine dimensions available for 307 cases. Uterine weight available for 245 cases.
‡ Ovarian dimensions only recorded for 60 patients with preoperative diagnosis of pelvic mass.
§ Node counts are from 22 patients with oncologic indications.

Table 6. Complications Analyzed by Body Mass Index Category

Complication	Ideal (n = 150)		Overweight (n = 95)		Obese (n = 78)	
	No reop (%)	Reop (%)	No reop (%)	Reop (%)	No reop (%)	Reop (%)
Urologic complications						
Bladder fistula, Foley	0	1 (.7)	0	0	0	0
Cystotomy, intraoperative repair	0	0	2 (2.1)	0	1 (1.3)	0
Ureter injury, intraoperative repair	1 (.7)	0	0	0	0	0
Ureter fistula, reimplanted	0	2 (1.3)	0	1 (1.1)	0	0
Ureter fistula, stented	0	1 (.7)	0	1 (1.1)	0	0
Urologic subtotal	1 (.7)	4 (2.6)	2 (2.1)	2 (2.1)	1 (1.3)	0
Adhesive bowel obstruction	0	0	0	1 (1.1)	0	1 (1.3)
Colon injury	0	1 (.7)	0	0	0	0
Trochar site hernia	0	0	0	1 (1.1)	0	0
Pelvic cellulitis	2 (1.3)	0	0	0	0	0
Pelvic abscess	0	1 (.7)	0	0	0	0
Pelvic hematoma	3 (2.0)	2 (1.3)	0	0	0	0
Pelvic seroma	0	0	2 (2.1)	0	0	0
Vaginal nonhealing	0	1 (.7)	0	1 (1.1)	0	0
Vaginal cuff bleed	0	1 (.7)	0	2 (2.2)	0	0
	6/150 (4.0)	10/150 (6.6)	4/95 (4.2)	7/95 (7.4)	1/78 (1.3)	1/78 (1.3)
Total		16/150 (10.7)		11/95 (11.6)		2/78 (2.6)

Reop = reoperation.
Reoperated, $P = .161$, χ^2 test.
Not reoperated, $P = .452$, χ^2 test.
Total complications, $P = .073$, χ^2 test.

in the sizes of the pelvic masses for the three groups of patients was found. Thirteen patients had masses with diameters more than 10 cm, with an average of 8.0 cm overall. The number of lymph nodes obtained laparoscopically from the 22 patients with oncologic indications did not vary by BMI group.

The overall complication rate for the series was 8.9% (Table 6), with no significant variation between the three categories of BMI. Reoperative, or major, complications occurred in 5.5% of patients, without significant variance between groups. Nonsurgical, or minor, complications occurred among 3.4% of the series, with no significant difference between size groups. Urologic complications occurred in all groups (overall, 3.1%), with 3.3% in ideal BMI, 4.2% in overweight, and 1.3% of obese women. Across the groups, 1.2% did not require reoperation for urologic complications, but 1.9% did need cystoscopic stenting or laparotomy with ureteral reimplantation. Seven of ten total urologic injuries occurred in the first one third of patients in the clinical series. The rate of urologic injuries is 1.3% in the last two-thirds of cases.

DISCUSSION

A search of the National Library of Medicine, MEDLINE, using the Endnote application with keywords "total laparoscopic hysterectomy," or "laparoscopic hysterectomy" and "body mass index," or "obesity" with no time limitations, confirms that this is the first report of the relationship of BMI to the outcomes in a large series of patients having a total laparoscopic hysterectomy. On the basis of the results of this series, this technique can be recommended for randomized clinical trials as a potentially safe alternative to open laparotomy hysterectomies for all weight categories of women.

Laparoscopic surgery in the obese gynecologic patient can be technically challenging. Establishment and maintenance of the pneumoperitoneum pose significant difficulty, given the thickness of the abdominal wall and the amount of preperitoneal fat.[5] A direct trochar entry technique[21] with elevation of the umbilicus by towel clips proved efficient even in the patients with high BMI. Although large women tolerate increased intraperitoneal pressure well with regard to cardiac function,[23] respiratory mechanics can be adversely affected for the duration of the pneumoperitoneum.[24] In particular, large women often need higher than usual inspiratory pressures, especially in Trendelenburg position, because the weight of the abdominal wall, bowel, and omentum reduces ventilatory compliance during the surgery.[5] None of the surgeries in the present series were prematurely terminated because of excessive ventilatory pressures or hypercarbia, but two patients required two to three interruptions of the pneumoperitoneum to allow the partial pressure of carbon dioxide to reduce with ventilation. In one surgical series, an association with conversion to open laparotomy was observed with increasing BMI over 30 kg/m^2.[25] In our series, seven

patients were converted early in the cases as a result of unfavorable surgical anatomy, newly recognized inapplicability of the procedures, or lack of functional equipment. No patients were converted to laparotomy because of difficulties attributed to high BMI.

In all three BMI groups, 39% of the patients were nulliparous. Many would have required open laparotomy or conversion to laparotomy from LAVH if total laparoscopic hysterectomy were not available to them. Because all of the dissections in the total laparoscopic hysterectomy are performed from above, via laparoscopic approach, the capacity to perform total laparoscopic hysterectomy appears to extend the benefits of minimally invasive surgery to women with no descensus or who have long, narrow vaginas.

Some surgeons advocate attempting vaginal hysterectomy or LAVH on all women needing hysterectomy, reserving total laparoscopic hysterectomy for those who cannot be completed vaginally.[26,27] We find that a total laparoscopic approach is facile and efficient, which others have also found.[28–30] Even for women with descensus and vaginal capacity, we still prefer to work from above, because vaginal hysterectomies have been associated with higher risk of urinary incontinence and vault prolapse.[31–33] This is likely because the women who qualify for a vaginal hysterectomy or LAVH are usually parous, and the closure from below may not offer vaginal hysterectomy patients the greatest support specifically because it is undertaken from below. Our technique incorporates the uterosacral ligaments with the round ligaments in the lateral apical closure sutures, which gives visible elevation of the vaginal apex not achievable from below. Anecdotally, a few patients have reported improvement in their mild stress urinary leakage after total laparoscopic hysterectomy, a benefit that we theorize may be attributable to the vaginal suspension.

Many are concerned that there are significantly longer operating times with LAVH for the obese patient.[34] Our data for total laparoscopic hysterectomy show no difference in operating times on the basis of BMI of the patient (about 2.5 hours on average). Only prospective comparative trials will confirm whether total laparoscopic hysterectomy is more suitable than the LAVH for the obese woman needing hysterectomy, regardless of capacity and descensus of the vagina.

Additionally of concern is the fact that the operating times for our patients included more than 264 additional procedures, such as cholecystectomy, node dissection, Burch colpopexy, omentectomy, appendectomy, and fulguration of endometriosis. Inclusion of these cases with additional procedures can confound interpretation of the operating times, but this retrospective teaching series reflects a standard clinical practice. Certainly, future randomized controlled trials of total laparoscopic hysterectomy would need to be more rigorously controlled with regard to preoperative diagnosis and additional procedures permitted.

Duration of surgery has been reported to decrease over time with greater laparoscopic surgical experience.[35,36] Total laparoscopic hysterectomy also appears to take less time than LAVH.[14,37] Of note, our laparoscopic blood loss, surgical duration, and number of days in the hospital are all continuing to decrease over time, with nine of the ten most recent laparoscopic cases in the series losing 10 to 50 mL blood, and eight of the ten patients going home on postoperative day 1.

Our complication rates compare favorably with open laparotomy data. With open laparotomy, obese patients have been shown to have a higher incidence of wound infection and other complications resulting in extended hospitalizations and additional procedures, directly proportional to the BMI.[38] We observed a 8.9% total complication rate for our series. This rate is similar to traditional transabdominal[39] or more recent laparoscopic hysterectomy series.[40–43] There were no complications in the 15 patients with BMI over 40 kg/m^2. Overall, 3.1% sustained urologic injury, with a majority occurring early in the first chronological third of the patient series and 1.3% in remaining two thirds of the series. Our urologic complication rate is similar to recently reported rates of other laparoscopic hysterectomy series, ranging from 3.4% to 8.3%,[44–46] and provides further evidence to a learning curve effect, with rates decreasing over time.[29]

This methodology is limited in terms of generalizability, because many other gynecologic surgeons may not have the caseload of laparoscopic experience to develop the expertise in laparoscopic hysterectomy. Thus, the complication rates for other surgeons may indeed differ by the patient's BMI. It is likely that these data will be useful for the advanced laparoscopic surgeon who is already performing some type of laparoscopic hysterectomy and is prepared to make cautious advances in technique. Making any comparison in a retrospective study is very difficult. There are many variables existing between patients (eg, cancer status, nutritional status, medical comorbidities), which were not taken into account in this observational comparison. Additionally, there were more than 198 procedures performed in addition to the hysterectomy. Any future randomized clinical study would control for patients' baseline health and for additional procedures. This comparison should be viewed more as a feasibility or pilot study, serving as an indicator of future research focus. In the United States, where 26% of the adult population is obese and where laparoscopy is rapidly becoming the standard of

care,[47] it becomes important to focus on the feasibility and safety of performing laparoscopic approaches on larger women. Our data demonstrate that a total laparoscopic hysterectomy is as feasible and safe for patients with high BMI as it is for patients of ideal BMI. Complications are minimized with training, experience, and a meticulous approach. On the basis of this cohort of cases, randomized prospective studies comparing total laparoscopic hysterectomy with TAH, vaginal hysterectomy, and LAVH should be performed, including women with the full spectrum of BMI to validate the utility of each procedure the in the population.

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Address reprint requests to: Katherine A. O'Hanlan, MD, Gynecologic Oncology Associates, 4370 Alpine Road, Suite 104, Portola Valley, CA 94028; E-mail: ohanlan@aol.com.

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