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Laparoscopic surgery for endometrial cancer: increasing body mass index does not impact postoperative complications

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Objective: To determine the effect of body mass index on postoperative complications and the performance of lymph node dissection in women undergoing laparoscopy or laparotomy for endometrial cancer.
Methods: Retrospective chart review of all patients undergoing surgery for endometrial cancer between 8/2004 and 12/2008. Complications graded and analyzed using Common Toxicity Criteria for Adverse Events ver. 4.03 classification.
Results: 168 women underwent surgery: laparoscopy n=65, laparotomy n=103. Overall median body mass index 36.2 (range, 18.1 to 72.7) with similar distributions for age, body mass index and performance of lymph node dissection between groups. Following laparoscopy vs. laparotomy the percent rate of overall complications 53.8:73.8 ($p=0.01$), grade ≥3 complications 9.2:34.0 ($p<0.01$), ≥3 wound complications 3.1:22.3 ($p<0.01$) and ≥3 wound infection 3.1:20.4 ($p=0.01$) were significantly lower after laparoscopy. In a logistic model there was no effect of body mass index (≥36 and<36) on complications after laparoscopy in contrast to laparotomy. Para-aortic lymph node dissection was performed by laparoscopy 19/65 (29%): by laparotomy 34/103 (33%) $p=0.61$ and pelvic lymph node dissection by laparoscopy 21/65 (32.3%): by laparotomy 46/103 (44.7%) $p=0.11$. Logistic regression analysis revealed that for patients undergoing laparoscopy for stage I disease there was an inverse relationship between the performance of both para-aortic lymph node dissection and pelvic lymph node dissection and increasing body mass index ($p=0.03$ and $p<0.01$ respectively) in contrast to the laparotomy group where there was a trend only ($p=0.09$ and 0.05).
Conclusion: For patients undergoing laparoscopy, increasing body mass index did not impact postoperative complications but did influence the decision to perform lymph node dissection.

Keywords: Body mass index, Endometrial cancer, Laparoscopy, Laparotomy, Obesity

INTRODUCTION

Around the world there are >198,000 new cases of endometrial cancer (EC) per year and over 50,000 deaths [1] whilst in the USA there are >43,000 new cases and >7,900 deaths [2]. The primary treatment for EC is surgery and the International Federation of Obstetrics and Gynecology (FIGO) staging system is surgical [3]. Traditionally, the surgery has been by laparotomy but laparoscopic techniques are now widely used because of an improved morbidity profile for equivalent survival [4].

Originally, patients selected for laparoscopy for EC tended to

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have lower body mass index (BMI) [5] but obese patients have been shown to gain the most from laparoscopy [6]. Obesity is not only a major risk factor for the development of EC [7] but it increases postoperative complications, especially wound infection, and is associated with factors such as hypertension, heart disease and diabetes which add additional surgical risk.

Despite the prevalence of obesity in EC, there are surprisingly few reports of laparoscopy in populations with a high median or mean BMI, ≥35 [5,8-10] or ≥30 [11-16] and the precise influence of BMI on complication rates and on the surgery performed within these series has not been clearly delineated.

Our objective was to analyze experience with laparoscopy and laparotomy for EC within an obese population to determine the effect of BMI on postoperative complications and the performance of lymph node dissection (LND).

MATERIALS AND METHODS

This was a retrospective cohort study. After approval of the Institutional Review Board all women undergoing surgical treatment for EC within a Cancer Center-based gynecologic oncology service between November 2003 and December 2008 were identified. Relevant medical records were retrieved between June 2009 and December 2010. Follow-up was either in the Cancer Center or nearer to home. Where necessary follow-up information was obtained from the hospital tumor registry or from patients in person. Histology details were obtained from the surgical pathology reports and tumor conference records. For analysis, high-risk histologic subtypes (serous, clear cell or mixed containing serous or clear cell) were grouped together under serous, whereas endometrioid histology included endometrioid with mucinous elements.

Surgery was performed by four gynecologic oncologists within a residency training program. The decision to perform laparoscopy or laparotomy was by surgeon preference but by the end of the study period all patients with clinically early stage disease (confined to the uterus) were selected for laparoscopy provided that they were considered capable of tolerating the procedure. Laparotomy utilized either a midline or low transverse incision, with panniculectomy in a minority to facilitate surgery. The decision to perform a LND was based on prognostic factors (grade of primary tumor, depth of myometrial invasion, size of primary tumor) and the feasibility of surgery based on the patient's medical condition and body habitus. LND was preferred for tumors of grade 3, grade 1 and 2 with outer half myometrial invasion, and tumors with obvious cervical involvement, spread outside the uterus or of high risk (serous, clear cell) subtype.

The laparoscopic technique of obtaining entry to the peritoneal cavity most commonly consisted of direct entry using a 5 mm Optiview port (Ethicon Endosurgery, Cincinnati, OH, USA) in the left upper quadrant of the abdomen followed by placement of a 10 mm camera port at the umbilicus, 5 mm ports in both iliac fossa and a 10 mm port suprapubically. Surgical specimens were normally removed through the vagina whilst larger specimens were removed using an extended port incision. Lymph node (LN) were removed in a bag through a 10 mm port or the vagina. Laparoscopic hysterectomy was early on performed by laparoscopic-assisted vaginal hysterectomy (LAVH) and later by total laparoscopic hysterectomy (TLH) and robotic-assisted (TRH) (Intuitive Surgical Inc., Sunnyvale, CA, USA) with the entire procedure performed from above. For the laparoscopic approach it was standard practice to use a RUMI uterine manipulator (CooperSurgical Inc, Trumbull, CT, USA).

For analysis, patients were divided into two groups: those treated by laparotomy and those in whom the intention was to perform the surgery laparoscopically. Patients were classified as having their surgery 'converted' to laparotomy whenever laparoscopy was discontinued so that surgery could be completed through a laparotomy incision or an extension of a regular port incision to remove the uterus. BMI was calculated using the formula BMI=weight (kg)/[height (m)]^2. A presumptive FIGO stage based on the parameters available was assigned to patients who did not undergo complete surgical staging. All adverse events were recorded and divided into intra-operative and postoperative within two months of surgery. Postoperative complications were graded according to the National Cancer Institute Common Toxicity Criteria for Adverse Events grading system (CTCAE ver. 4.03) [17]. The degree of wound pain was recorded as present or absent. Wound separation included wounds that opened spontaneously and those that were opened in order to assist healing. Analysis was performed by the 'intention to treat' basis.

1. Statistical methods

The distributions for patient characteristics and different complications between laparoscopy and laparotomy groups were compared using the Wilcoxon rank sum test for continuous variables and χ^2-test (or Fisher's exact test when the expected frequency within any cell was less than 5 in a 2×2 table) for categorical variables (Tables 1 and 2). Given that the impact of BMI on outcome variables was very important, we grouped patients into broad BMI groups (BMI ≥36 or BMI<36), using the median cut-off criterion. In each of the surgery approaches, the association between BMI class (BMI ≥36 or BMI<36) and different lymph node dissections (any LND, para-

Table 1. Patient characteristics by surgical approach (n=168)

Variables	Laparoscopy (n=65)	Laparotomy (n=103)	Total (n=168)	p-value
Age (yr)	57 (27-83)	59 (30-89)	58 (27-89)	0.78
<50	19 (29.2)	22 (21.4)	41 (24.4)	0.23
50-65	23 (35.4)	50 (48.5)	73 (43.5)	
≥65	23 (35.4)	31 (30.1)	54 (32.1)	
Race, white	61 (93.8)	98 (95.1)	159 (94.6)	0.74
BMI	35.0 (19.3-60.6)	37.5 (18.1-72.7)	36.2 (18.1-72.7)	0.07
<36	36 (55.4)	47 (45.6)	83 (49.4)	0.23
≥36	29 (44.6)	56 (54.4)	85 (50.6)	
LND at laparotomy	7 (10.8)			
Stage of disease				
IA	17 (26.6)	26 (25.2)	43 (25.7)	0.24
IB	32 (50.0)	46 (44.7)	78 (46.7)	0.17*
IC	8 (12.5)	7 (6.8)	15 (9.0)	0.02†
II	5 (7.8)	10 (9.7)	15 (9.0)	
III	2 (3.1)	10 (9.7)	12 (7.2)	
IV	0 (0.0)	4 (3.9)	4 (2.4)	
Grade of disease				
I	32 (49.2)	51 (49.5)	83 (49.4)	0.81
II	22 (33.8)	31 (30.1)	53 (31.5)	
III	11 (16.9)	21 (20.4)	32 (19.0)	
Histology				
Endometrioid	60 (92.3)	97 (94.2)	157 (93.5)	0.75
Serous	5 (7.7)	6 (5.8)	11 (6.5)	
Other procedure	2 (3.1)	24 (23.3)	26 (15.5)	<0.01
Previous abdominal surgery	24 (36.9)	29 (28.2)	53 (31.5)	0.21
LND performed	23 (35.4)	46 (44.7)	69 (41.1)	0.23
PALND performed	19 (29.2)	34 (33.0)	53 (31.5)	0.61
PLND performed	21 (32.3)	46 (44.7)	67 (39.9)	0.11
No. of LN	17 (3-38)	14 (0-46)	16 (0-46)	0.22
No. of PALN	7 (4-20)	5 (0-14)	5 (0-20)	<0.01
No. of PLN	14 (5-28)	11 (1-37)	13 (1-37)	0.76
Duration of surgery (min)	265 (120-480)	210 (75-360)	231 (75-480)	<0.01
Estimated blood loss (mL)	100 (10-600)	200 (50-2500)	200 (10-2500)	<0.01
Duration of hospital stay (day)	2 (1-12)	4 (2-18)	4 (1-18)	<0.01
Time to flatus (day)	2 (1-9)	4 (1-10)	3 (1-10)	<0.01
Postoperative Hb	11.1 (8.6-14.4)	10.8 (7.4-14.4)	11.0 (7.4-14.4)	0.04

Values are presented as number (%) or median (range).
BMI, body mass index; LND, lymph node dissection; PALND, para-aortic lymph node dissection; PLND, pelvic lymph node dissection; FIGO, International Federation of Obstetrics and Gynecology; PALN, para-aortic lymph nodes; PLN, pelvic nodes; Hb, hemoglobin.
*IA vs. IB vs. IC vs. II vs. III or higher. †I or II vs. III or higher.

aortic LND [PALND] and pelvic LND [PLND]) were estimated using Fisher's exact test within stage I and for all stages (Table 3). Due to the ordinal patients' characteristics (such as age, surgery duration), we used Fisher's Z transformation before calculating Pearson correlation between BMI and other characteristics (Table 4) [18]. Within each surgery approach, we used logistic regression models to explore the effect of BMI on complications and we use a superscript * to identify signifi-

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Table 2. Distribution of complications by surgical approach and conversion to laparotomy (n=168)

Variables	Laparoscopy converted to laparotomy			Laparotomy (n=103)	p-value‡
	No (n=53)	Yes (n=12)	p-value		
Intra-operative complication	4 (7.5)	0 (0.0)	0.59	4 (3.9)	0.71
Complications any grade*	25 (47.2)	10 (83.3)	0.02	76 (73.8)	0.01
Complication, grade ≥3	2 (3.8)	4 (33.3)	0.01	35 (34.0)	<0.01
Peri operative mortality	1 (1.9)	0 (0.0)	1.00	2 (1.9)	1.00
Wound any kind	6 (11.3)	5 (41.7)	0.02	52 (50.5)	<0.01
Wound†	0 (0.0)	2 (16.7)	0.03	23 (22.3)	<0.01
Wound pain	5 (9.4)	0 (0.0)	0.58	23 (22.3)	0.01
Wound infection†	0 (0.0)	2 (16.7)	0.03	21 (20.4)	0.01
Wound separation	0 (0.0)	2 (16.7)	0.03	27 (26.2)	<0.01
Pulmonary†	1 (1.9)	0 (0.0)	1.00	2 (1.9)	1.00
Venous thrombo-embolism†	0 (0.0)	0 (0.0)	0.63	2 (1.9)	0.52
Head†	0 (0.0)	0 (0.0)	0.63	3 (2.9)	0.28
Gastro-intestinal†	0 (0.0)	0 (0.0)	0.63	1 (1.0)	1.00
Cardiac†	1 (1.9)	2 (16.7)	0.09	3 (2.9)	0.68
Renal†	0 (0.0)	1 (8.3)	0.19	0 (0.0)	0.39
Vagina	2 (3.8)	0 (0.0)	1.00	3 (2.9)	1.00
Reoperation	0 (0.0)	0 (0.0)	0.49	6 (5.8)	0.08
Anemia†	0 (0.0)	0 (0.0)	0.63	5 (4.9)	0.16
Postoperative transfusion	0 (0.0)	3 (25.0)	0.01	14 (13.6)	0.06

Due to small cell frequency, some of the p-values are not reliable.
*Does not include patients reporting wound pain. †Grade ≥3. ‡Laparoscopy vs. laparotomy.

Table 3. Distribution and test of association between lymph node dissection and BMI using logistic regression

Type of dissection	Stage of disease	Laparoscopy			Laparotomy		
		BMI < 36	BMI ≥ 36	p-value	BMI < 36	BMI ≥ 36	p-value
Lymph node dissection	IA	4/8	1/9	0.13	4/11	3/15	0.41
	IB	6/16	1/16	0.08	9/18	10/28	0.37
	IB or IC	12/23	2/17	0.02	10/20	13/33	0.57
	Total all stages	18/36	5/29	0.01*	26/47	20/56	0.05*
Para-aortic LND	IA	4/8	1/9	0.13	1/11	0/15	0.42
	IB	5/16	1/16	0.17	7/18	8/28	0.53
	IB or IC	10/23	2/17	0.04	8/20	11/33	0.77
	Total all stages	15/36	4/29	0.03*	20/47	14/56	0.09
Pelvic LND	IA	4/8	1/9	0.13	4/11	3/15	0.41
	IB	5/16	1/16	0.17	9/18	10/28	0.37
	IB or IC	11/23	1/17	<0.01	10/20	13/33	0.57
	Total all stages	17/36	4/29	<0.01*	26/47	20/56	0.05*

The subgroup analysis may not be reliable due to the small sample size.
BMI, body mass index; LND, lymph node dissection.
*Indicates variables significantly associated with BMI≥36 vs. BMI<36 in logistic regression model at alpha=0.05.

Table 4. Correlation between body mass index and continuous characteristics by surgical approach

Characteristics	Laparoscopy		Laparotomy	
	$\hat{\rho}$	p-value	$\hat{\rho}$	p-value
Patient no.	65		103	
Age	-0.354	<0.01	-0.441	<0.01
Surgery duration	0.003	0.98	0.196	0.04
Estimated blood loss	0.130	0.30	0.099	0.32
Duration of hospital stay	-0.021	0.88	-0.005	0.96
Time to flatus	-0.092	0.46	-0.152	0.12
Postoperative Hb	-0.228	0.07	-0.062	0.54
PALN total	0.054	0.83	-0.378	0.03
PLN total	0.096	0.68	-0.012	0.94
Lymph node total	0.233	0.30	-0.155	0.32

Hb, hemoglobin; PALN, para-aortic lymph nodes; PLN, pelvic lymph nodes.
$\hat{\rho}$ is a correlation coefficient determined using the Pearson correlation test by Fisher's z transformation. $\hat{\rho}>0$ indicates the variable increases as BMI increases (e.g., surgery duration at laparotomy) and $\hat{\rho}<0$ indicates the variable decreases as BMI increases (e.g., PALN total when performed at laparotomy). $\hat{\rho}=0$ indicates there is no correlation.

cant results in Tables 3.

The Kaplan-Meier method [19] was used to estimate the overall survival (OS) and progression free survival (PFS). Survival differences were compared using the un-weighted log-rank test [20]. The OS time was determined as the time from surgery until death or last follow-up evaluation. The PFS time was determined as the time from surgery until the first adverse event (i.e., disease progression, second malignancy, or death due to any cause). All calculations were performed with SAS (SAS Institute Inc., Cary, NC, USA) [21].

RESULTS

Between November 2003 and December 2008, 168 women underwent surgery for EC (103 laparotomy and 65 laparoscopy). In the laparoscopy group 13 (20%) underwent LAVH, 33 (50.7%) TLH, 8 (12.3%) TRH and 4 (6.1%) TAH after conversion to laparotomy whilst 7 (10.8%) had had a prior hysterectomy. Of the laparoscopic cases, 41 (63%) were performed by one surgeon (CWH) and 24 (37%) by the three other surgeons with the number of cases and experience increasing for all surgeons over time, 19 (29%) being performed in the years 2003-2006 and 46 (71%) 2007-2008. Patient characteristics by surgical approach are given in Table 1. The median BMI was 36.2 (range, 18.1 to 72.7). There was no difference between the two groups with regard to age, race, BMI, histologic subtype or grade of disease or in the percentage undergoing LND (either PALND or PLND or both) in either group: 23/65 (35.4%) laparoscopy and 46/103 (44.7%) laparotomy (p=0.23). Twelve of 65 (18.5%) originally taken to the operating room with the intent to perform laparoscopy were converted to laparotomy for the following reasons and with associated BMI: extensive adhesions (n=3) 21.3, 22.9, 29.3, to complete staging (n=2) 32.9, 35.1, to remove a large uterus (n=3) 41.0, 56.2, 59.7, inadequate exposure due to subperitoneal fat (n=1) 24.2, and unable to tolerate 'head down' position or pneumoperitoneum (n=3) 31.3, 51.6, 60.6. Two patients had a combination of factors leading to conversion BMI 60.64 and 31.3.

Significantly more patients in the laparotomy group underwent additional procedures other than hysterectomy and/or BSO, PALND, or PLND (Table 1): 24/103 (23.3%) versus 2/65 (3%) (p<0.01). In the laparotomy group, the 29 additional procedures performed in 24 patients were: partial omentectomy (n=10), hernia repair (n=6), panniculectomy (n=3), small bowel resection (n=2), appendectomy (n=2), colostomy repair (n=1), omental J flap (n=1), liver biopsy (n=1), colposacropexy (n=1), and urethral sling procedure and upper vaginectomy (n=1). In the laparoscopy group, the additional procedures were urethral sling procedure (n=1) and umbilical hernia repair (n=1). There was no significant difference in the proportion of patients undergoing previous abdominal surgery in the laparoscopy and laparotomy groups (24/65 [36.9%] vs. 29/103 [28.2%]; p=0.21) and none of these were for cancer.

The median number of PALN removed was greater in the laparoscopy versus laparotomy group but there was no difference in the median number of pelvic LN (PLN), or overall number of LN removed (Table 1).

Estimated blood loss, time to flatus, and duration of hospital stay were less in the laparoscopy group whilst the duration of surgery was longer (Table 1). After laparotomy the postoperative hemoglobin (Hb) was lower than after laparoscopy (Table 1). There were no port-site metastases and no vaginal dehiscences in the laparoscopy group. Four non-severe intra-operative complications occurred in each group. In the laparotomy group they were: colotomy repaired primarily and protected with omental J flap, bleeding from the inferior vena cava (n=2) and hypotension whilst in the laparoscopy group they were: bladder muscular injury repaired, bleeding from epigastric artery caused by the suturing device at closure, small vaginal tear while removing large uterus and hypercarbia causing temporary interruption of the procedure. There were 3 perioperative deaths, one after laparoscopy (sudden collapse at home on postoperative day 8 with cause of death given as cardiac arrest) and two after laparotomy (one a cardiac ar-

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Table 5. Overall survival and progression free survival probability for FIGO stage I by surgical approach

Type	Approach	No. of patients	Survival percentage and standard error										p-value
			1-yr		2-yr		3-yr		4-yr		5-yr		
			%	SE	%	SE	%	SE	%	SE	%	SE	
OS	Laparoscopy	59	98.2	2.0	98.2	3.1	98.2	3.6	98.2	5.9	98.2	9.3	0.12
	Laparotomy	79	96.1	2.5	94.4	4.1	90.1	7.3	77.2	21.3	77.2	36.9	
PFS	Laparoscopy	59	100	0.0	100	0.0	100	0.0	100	0.0	100	0.0	0.39
	Laparotomy	79	100	0.0	97.6	2.8	97.6	3.9	97.6	8.7	97.6	15.1	

FIGO, International Federation of Obstetrics and Gynecology; SE, standard error; OS, overall survival; PFS, progression free survival.

rest on postoperative day 4 and the other sudden collapse at home on postoperative day 47). No post mortems were performed.

Complications of any grade excluding pain and grade ≥3 complications were significantly more common after laparotomy (p=0.01, p≤0.01) Table 2. Only two patients experienced grade ≥3 complications after undergoing the entire procedure laparoscopically, one pneumonia and the other sudden death at home postoperative day 8. Although there was no significant difference in the incidence of postoperative anemia ≥3, 14 (13.6%) received a postoperative transfusion after laparotomy versus 3 (4.6%) after laparoscopy (p=0.06) with all 3 being converted to laparotomy (Table 2). Wound complications and complications of any kind ≥3 were significantly more common in the 12 patients in the laparoscopy group who were converted to laparotomy compared to the 53 patients in the laparoscopy group who underwent surgery without conversion. In contrast, there was no difference in these complications between the 12 patients converted from laparoscopy to laparotomy and the 103 patients in the laparotomy group (Table 2). Six (5.8%) patients in the laparotomy group underwent a further operative procedure, 5 wound debridements and one colostomy for a recto-vaginal fistula. No patients in the laparoscopy group needed a further surgery (p=0.08).

Analysis of the correlation between BMI and continuous characteristics by surgical approach (Table 4) showed that in the laparoscopy group increasing BMI did not impact the durations of surgery or hospital stay, time to flatus or number of PALN and PLN removed nor the estimated blood loss, whereas it was associated with a trend towards a lower postoperative Hb level (p=0.07). In the laparotomy group increasing BMI was associated with longer duration of surgery and lower number of PALN removed.

In a logistic model to examine the effect of BMI (≥36 and<36) on complications within the laparotomy and laparoscopy groups, there was no relationship between complications and BMI within the laparoscopy group. In contrast, in the laparotomy group, wound complications of any kind (p<0.01), grade ≥3 wound (p≤0.01), grade ≥3 wound infection (p=0.01) and wound separation (p=0.02) were all significantly related to BMI.

In the laparoscopy group within stage I (Table 3) there was an inverse relationship between the performance of LND of any kind (p=0.01), PALND (p=0.03), and PLND (p<0.01) and increasing BMI in contrast to the laparotomy group where there was a trend only.

The overall median follow-up time from surgery was 17.2 months and 17.4 months for patients who were alive at the time of the last follow-up. For FIGO stage I (Table 5), OS and PFS were similar between groups (p=0.12, p=0.39) after median follow-up of 12.8 months (range, 0 to 59.3 months). As expected with the higher incidence of patients with FIGO stage ≥ II the OS was worse in the laparotomy group (data not shown).

DISCUSSION

The key results in this study are that increasing BMI significantly impacted the decision to perform LND in patients undergoing laparoscopic surgery but it did not impact postoperative morbidity. The report contains a population with a high median and mean BMI (35.0 and 36.0) with over 50% in both the laparoscopy and laparotomy groups being obesity class II or greater according to the World Health Organization International Classification of Obesity in which BMI ≥30 (overweight), 30-34.99 (class I), 35-39.99 (class II), and ≥40 (class III) [22]. In contrast to laparotomy, many reports of laparoscopy for EC either specifically exclude women with high BMI [23] or the local populations have a low prevalence of obesity [24]. Studies reporting the use of laparoscopy for EC where the median or mean BMI are ≥30 are detailed in Table 6.

We classified the complications of surgery according to the CTCAE ver. 4.03 [17]. Only one other study has used an earlier version of this grading system [23] which standardizes the reporting of complications and facilitates comparisons and

Table 6. Reports of laparoscopy for endometrial cancer with median or mean BMI≥30

Author year	Type	No.	BMI median (range)	BMI mean (range)	Conversion (%)	PALND (%)	PLND (%)	Any LND (%)
Eltabbakh 2000 [5]	P	40	-	35.8 (28.9-55)	7.5	7.5	60	67.5
Scribner 2002 [8]	R	55	-	40 (28-61.7)	36.4	100	100	100
Tozzi 2005 [11]	RAN	63	-	31.3 (20.2-43.6)	7.9	60.3	84	-
O'Hanlan 2005 [12]	R	76 59	-	30.5, SD 8.9	1.3	-	-	28
O'Hanlan 2006 [13]	R	90 64	-	30.2 (18-60.7)	3.3	30	30	30
Eisenhauer 2007 [9]	R	25	39 (35-49)	-	16	36	40	40
Gehrig 2008 [14]	R	32	-	32 (30-55)	9.4	90.6	87.5	94
Bell 2008 [15]	R	30	-	31.9, SD 9.8	-	100	100	100
Eisenkop 2010 [16]	R	210	30.2 (16.6-65.5)	31.4, SD 8.69	4.7	100	100	100
Fanning 2010 [10]	P	235	-	39 (22-77)	3	17.8	100	100
Current series	R	65	35.0 (19.3-60.6)	36.0 (33.4-38.6)*	18.5	32.3	33.8	35.4

BMI, body mass index; PALND, para-aortic lymph node dissection; PLND, pelvic lymph node dissection; LND, lymph node dissection; P, prospective; R, retrospective; RAN, randomized; SD, standard deviation; CI, confidence interval.
*95% confidence interval.

statistical analysis. The universal adoption of this system in future would avoid the difficulties of comparing complication rates when either no [5,6,8,12-14,16,25-36], subjective [15,24] or institutional [9] classifications are used. Its use should be encouraged.

In our series overall complications occurring during and after laparoscopy surgery were not related to the BMI. Two reports amongst the few in the literature that include populations with a high median or mean BMI ≥35 [5,8-10] or ≥30 [11-16] (Table 6) came to a similar conclusion [13,14] although another reported an increase in complications within a subset of patients having age>65 years, weight >80 kg, a BMI>30 with at least one of the following co-morbidities: diabetes, hypertension or cardio-respiratory failure [11]. The overall lack of relationship between BMI and complications after laparoscopy for EC is in marked distinction to patients undergoing laparotomy where patients with BMI ≥36 have a significantly greater incidence of wound complications including severe infection, wound separation and likelihood of postoperative transfusion. This association is well known in patients undergoing laparotomy for benign conditions and EC [32]. Since the greatest benefits from laparoscopy are seen in patients with high BMI we agree with others that it should be the initial approach of choice for such patients [11,32].

Our conversion rate of 18.5% is high in relation to some recent studies (Table 6) but is within the literature range of 0-36.4% [5,8,9,11-13,16,23,25-28,30-35,37,38]. This is almost certainly due to the learning curve since in 6 of the cases (adhesions [n=3], for staging [n=2], inadequate exposure due to subperitoneal fat [n=1]), conversion would probably now be avoided as a result of increased experience. This would reduce the complete conversion rate (excluding laparotomy to remove large uteri) to 3 of 65 = 4.6% which would include those with obesity-related problems such as inability to tolerate the head down position and pneumoperitoneum. Of note is that, in this series, patients who were converted to laparotomy from laparoscopy had complications similar to those undergoing planned laparotomy (Table 2).

Childers et al. [39] was the first to report that obesity was the limiting factor in performing LND among women with EC. In our series, performance of both PALND and PLND was inversely related to the BMI (Table 3). In series containing populations with high median or mean BMI (Table 6) there was reported to be no influence overall [13] or no influence on PLND specifically [6]. With regard to PALND, Tozzi et al. [6] reported 'minimal influence' and Scribner et al. [8] suggested that there was 'probably' an effect on PALND because of difficulties in access in obese patients, backed up by a conversion rate of 36.4% with the commonest reason being obesity. Eltabbakh et al. [5] reported that 5% of patients did not undergo PALND due to 'lack of exposure'. Others have reported the increased difficulty in performing PALND with increasing weight [30] and when the weight is >160 kg [32]. Even in papers that do not report on the impact of BMI on the performance of LND it is possible to infer an effect of BMI by examining the rate of conversion and the reasons for conversion. In the recent Gynecologic Oncology Group study the conversion rate was 25.8% of 1,682 patients randomized to undergo laparoscopy

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for staging of clinical stage I to IIA EC. Conversion occurred in 26.5% of patients with BMI 34-35 and 57.1% with BMI>40 [23].

However, it appears that the technical difficulties of PALND in the obese can be overcome and three studies (Table 6) reported rates of PALND of 90-100% [14-16] with low rates of conversion to laparotomy 9.4% and 4.7% [14,16] indicating that PALND is feasible in the majority of this population. BMI probably played a role in the performance of PALND because the reason for conversion in 2 of 10 patients in one study was inadequate exposure due to adhesions and obesity [16].

This report clearly has significant limitations in that it was retrospective, it included patients treated with LAVH, TLH, and TRH performed during transition from laparotomy to laparoscopy surgery for EC within a gynecologic oncology group of 4 surgeons, and it included no prospective analysis of pain or quality of life. However, these do not negate the significant findings that the BMI did not affect the rate of complications within the group undergoing laparoscopy, or the number of LN removed when a LND was performed. With regard to assessing the influence of the BMI on the decision to perform a LND, there were no mandated criteria for performance of LND or contemporary documentation of the reasoning behind the decision whether or not to perform LND but there was a group consensus with regards to the factors indicating the need for LND. This supports the finding that the decision whether or not to perform LND was, in part, related to the BMI of the patient. This has previously been only alluded to in other series including populations with a high BMI [5,8,30-32].

The question arises as to how to manage patients with a high BMI who are at increased risk for LN metastasis due to factors such as poor grade and deep myometrial invasion, cervical involvement and high-risk histologic subtypes. In such patients access to the para-aortic nodal bed is essential and presents more of a problem in these patients than pelvic node dissection. The data in this series applies only to the performance of transperitoneal LND and it may be that in such patients an extraperitoneal approach may give more reliable access to the para-aortic nodes up to the left renal vein and duodenum.

Within our experience, for patients undergoing laparoscopic surgery for EC, increasing BMI did not impact postoperative complications or number of LN resected. However, the BMI did influence the decision to perform LND at laparoscopy.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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