Feasibility and Safety of Laparoscopic Surgery for Obese Korean Women with Endometrial Cancer: Long-Term Results at a Single Institution

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The purpose of this study was to evaluate the surgical feasibility of and survival outcome after laparoscopy in obese Korean women with endometrial cancer which has recently been increasing. We reviewed the medical records of the patients treated at our medical institution between 1999 and 2012. The patients were divided into three groups, non-obese (Body Mass Index [BMI] < 25.0), overweight (BMI 25-27.99), and obese (BMI ≥ 28.0). These patient groups were compared in terms of their clinical characteristics, treatment methods, as well as surgical and survival outcomes. In total, 55 of the 278 eligible patients were obese women. There were no differences in the three groups in terms of the proportion of patients who underwent lymphadenectomy, their cancer stage, histologic type, type of adjuvant treatment administered, intra-, post-operative, and long-term complications, operative time, number of removed lymph nodes, blood loss, and duration of hospitalization (P = 0.067, 0.435, 0.757, 0.739, 0.458, 0.173, 0.076, 0.124, 0.770, 0.739, and 0.831, respectively). The Disease-Free Survival (DFS) times were 139.1 vs. 121.6 vs. 135.5 months (P = 0.313), and the Overall Survival (OS) times were 145.2 vs. 124.8 vs. 139.5 months (P = 0.436) for each group, respectively. Obese women with endometrial cancer can, therefore, be as safely managed using laparoscopy as women with normal BMIs.

Keywords: Endometrial Neoplasms; Obesity; Laparoscopy; Surgical Outcome; Survival Outcome

INTRODUCTION

Endometrial carcinoma is one of the most common gynecologic cancers detected in Europe and the United States (1), and its incidence is increasing in Korea and other Asian countries due to higher fat diets and longer life spans. Exploratory laparotomy through a midline incision, total abdominal hysterectomy (TAH), bilateral salpingo-oophorectomy, peritoneal washing, and dissection of the pelvic or both the pelvic and para-aortic lymph nodes constitute the standard procedures used for the surgical staging of endometrial carcinoma (2). Recently, due to advances in the use of laparoscopic surgical techniques, laparoscopy has been reportedly used for both the exact staging and the effective treatment of endometrial carcinoma. It has also been demonstrated that laparoscopic surgery results in shorter hospital stays, earlier recovery times, and a better quality of life (3-5).

Obesity is a common risk factor for uterine neoplasia, and accounts for more than half of the patients with endometrial cancer (6, 7). Obesity also greatly increases the risk of developing endometrial cancer by as much as 40%. An earlier study reported that obesity is associated with a two- to five-fold increase in the risk of endometrial cancer in both pre- and postmenopausal women (8). There is also a linear increase in the endometrial cancer risk with an increasing body mass index (BMI) (9). However, the influence of a high BMI on the prognosis of endometrial carcinoma remains controversial. Obesity has been associated with a worse prognosis of endometrial carcinoma in several published studies, although there was no association in other and in Korean population studies (10-14). Obesity was once a contraindication for advanced laparoscopic procedures (15, 16), although this has recently been reconsidered (17). Improved instrumentation and techniques have allowed the safe use of many advanced laparoscopic procedures in women with a high BMI (18-22). However, there are few reports regarding the feasibility of laparoscopic hysterectomy and dissection of the pelvic or both the pelvic and para-aortic lymph nodes in obese Korean women. Therefore, study attempted to evaluate the feasibility and survival outcome of laparoscopy in obese Korean women with endometrial cancer.

MATERIALS AND METHODS

The medical records of all patients with uterine cancer who were treated at Asan Medical Center between January 1999 and August 2012 were retrospectively reviewed after we received institutional review board approval. In total, 555 patients with endometrial cancer were identified and all had undergone surgery at Asan Medical Center. Of these patients, 270 underwent open surgery and 285 underwent laparoscopic surgery. Four patients did not receive adequate follow-up examinations following surgery, and the medical records of three other patients were missing. As a result, 278 patients with early-stage endometrial cancer were eligible for inclusion in study. All of these patients were diagnosed using pelvic examinations and imaging modalities. They were divided into three groups, non-obese (BMI < 25.0), overweight (BMI 25-27.99), and obese (BMI ≥ 28.0), which is more strict and higher classification than the proposed International Obesity Task Force (IOTF) classifications for BMI in Asia (23, 24). The Korean Ministry of Health and Welfare and IOTF defined obesity in Korea and Asia as BMI ≥ 25, however, we defined obesity as BMI ≥ 28.0 in our study in order to reach global standard and to truly evaluate the feasibility and safety of laparoscopic surgery in obese women. Board-certified gynecologic oncologists performed the surgical procedures in all patients.

One of our patients in whom we performed laparotomy due to stromal adenocarcinoma with adenosquamous features, was included in our study cohort because most of the procedure was finished at the time of the frozen section was sent.

Laparoscopic pelvic lymphadenectomy was not performed in patients diagnosed with stage IA tumors and who had grade 1 differentiation with favorable histological findings. Therefore, pelvic lymphadenectomy was performed in patients with differentiation of grade 2 or above in stage IA, and unfavorable histological types, such as type II endometrial cancer, regardless of the stage and differentiation of the grade. Para-aortic lymphadenectomy was performed in patients with serous, adenosquamous, clear-cell or grade 3 tumors and in tumors with frozen sections demonstrating > 50% myometrial invasion. If grossly enlarged lymph nodes were not seen or if no metastases in the pelvic lymph nodes were found on analysis of the frozen sections, para-aortic lymphadenectomy was performed on the areas below the inferior mesenteric artery. Para-aortic lymphadenectomy above the infra mesenteric artery (IMA) was performed when there was an extra-uterine lesion seen on frozen sections or type II histology detected on the pre-operative dilation & currettage (D&C) biopsy. In our study, there were 12 patients who underwent para-aortic lymphadenectomy above the IMA.

A drain was inserted in all of the patients who underwent lymphadenectomy and in six of the 31 patients who underwent simple hysterectomy. Patient age, parity, BMI (kg/m^2), histological type, International Federation of Gynecology and Obstet-rics (FIGO) surgical stage (25), the number of harvested lymph nodes, operative time, post-operative hospital stay (calculated from the date of surgery to the date of discharge), estimated blood loss (EBL), need for intra-operative or post-operative blood transfusion, intra-, post-operative, and long-term complications, conversion to laparotomy, disease recurrence, and death were recorded as clinical parameters. Conversion to laparotomy, ureteral, bowel, bladder, and vascular injuries, an EBL > 1,000 mL, and blood transfusion were considered intra-operative complications. The surgical staging was determined according to the FIGO 2009 staging system (25). The dates and locations of any recurrences were recorded. Overall survival (OS) was calculated from the date of surgery to the date of the last follow-up examination or a patient's death. Disease-free survival (DFS) was calculated from the date of surgery to the date of recurrence or to the last follow-up examination in patients who did not develop recurrence. Statistical analyses were performed using SPSS (version 12.0). The Kaplan-Meier method was used to determine the recurrence rate, DFS, and OS for all patients. The log-rank test was also used to compare survival outcomes. Statistical significance was defined as $P < 0.05$.

Ethics statement

This study was reviewed and approved by the institutional review board (IRB) of Asan Medical Center (IRB approved protocol No. 2013-0301). As this study was a retrospective study using our institution's electrical database and medical records, informed consent was waived.

RESULTS

Patient age, height, parity, and history of previous laparotomies

Table 1. Patient characteristics

Parameters	BMI < 25 kg/m² (n = 146) (range), mean ± SD	BMI 25-27.99 kg/m² (n = 77) (range), mean ± SD	BMI ≥ 28 kg/m² (n = 55) (range), mean ± SD	P
Age (yr)	(26-72) 50.0 ± 8.8	(24-73) 52.8 ± 9.6	(29-76) 51.5 ± 11.4	0.124
Height (cm)	(143.8-173.7) 155.9 ± 5.7	(136.0-167.5) 155.6 ± 6.0	(142.1-175.0) 156.7 ± 5.8	0.571
Weight (kg)	(38.3-68.5) 54.7 ± 5.8	(47.0-75.0) 64.0 ± 5.3	(60.0-113.0) 76.2 ± 10.3	< 0.001
Body mass index	(16.9-25) 22.4 ± 1.8	(25-28) 26.4 ± 0.8	(28-42.2) 30.9 ± 3.0	< 0.001
Parity (median, range)	2.0 (0-5)	2.0 (0-6)	2.0 (0-8)	0.198
Previous laparotomy, No. (%)				0.466
None	118 (80.8)	65 (84.4)	44 (80.0)	
1	18 (12.3)	8 (10.4)	10 (18.2)	
≥ 2	10 (6.8)	4 (5.2)	1 (1.8)	
Medical problems, No (%)				0.025
None	100 (68.5)	44 (57.1)	24 (43.6)	
1	30 (20.5)	23 (29.9)	22 (40.0)	
≥ 2	16 (11.0)	10 (13.0)	9 (16.4)	

were similar in the three patient groups (Table 1). Obese patients demonstrated more medical problems than the non-obese and overweight group patients (*P* = 0.025). Disease characteristics, procedures, and adjuvant treatments for the study subjects are indicated in Table 2. There were no significant differences between the non-obese, overweight, and obese groups in terms of the surgical stage, histology, procedure, and type of adjuvant therapy. The majority of women in the three groups were diag-

Table 2. Disease characteristics, procedures, and adjuvant treatments

Clinical parameters	No. (%) of patients by BMI			*P*
	BMI < 25 (n = 146)	BMI 25-27.99 (n = 77)	BMI ≥ 28 (n = 55)	
Surgical stage				0.435
I	122 (83.6)	71 (92.2)	51 (92.7)	
II	6 (4.1)	2 (2.6)	1 (1.8)	
III	16 (11.0)	4 (5.2)	3 (5.5)	
IV	2 (1.4)	0 (0)	0 (0)	
Histological type				0.757
Endometrioid	115 (78.8)	65 (84.4)	47 (85.5)	
Adenosquamous	2 (1.4)	2 (2.6)	1 (1.8)	
Serous papillary	11 (7.5)	7 (9.1)	5 (9.1)	
Clear-cell	2 (1.4)	0 (0)	0 (0)	
Carcinosarcoma	1 (0.7)	1 (1.3)	0 (0)	
Uterine sarcoma	10 (6.8)	1 (1.3)	1 (1.8)	
Mucinous adenocarcinoma	2 (1.4)	0 (0)	0 (0)	
Mixed	3 (2.1)	1 (1.3)	1 (1.8)	
Procedure				0.067
Hysterectomy only	22 (13.2)	6 (6.2)	3 (4.3)	
Hysterectomy + pelvic lymphadenectomy	89 (53.3)	65 (67)	45 (64.3)	
Hysterectomy + pelvic/para-aortic lymphadenectomy	56 (33.5)	26 (26.8)	22 (31.4)	
Adjuvant treatment				0.739
No	91 (62.3)	50 (64.9)	37 (67.3)	
Radiotherapy	23 (15.8)	8 (10.4)	7 (12.7)	
Chemotherapy	16 (11.0)	9 (11.7)	8 (14.5)	
Both	16 (11.0)	10 (13.0)	3 (5.5)	

Table 3. Surgical and survival outcomes

Outcomes	Mean ± SD (range)			*P*
	BMI < 25 (n = 146)	BMI 25-27.99 (n = 77)	BMI ≥ 28 (n = 55)	
Operative time (min)	(65-415) 180.7 ± 62.8	(63-524) 182.8 ± 73.1	(75-325) 184.5 ± 51.2	0.124
Estimated blood loss (mL)	(10-800) 233.3 ± 154.8	(30-1300) 244.6 ± 189.0	(10-3000) 261.6 ± 401.1	0.739
Post-operative drop in Hb (g/dL)	(0.1-5.4) 1.9 ± 1.2	(0.1-5.5) 2.0 ± 1.0	(0.2-5.2) 1.9 ± 1.1	0.748
Hospital stay (day)	(2-36) 7.9 ± 5.6	(2-65) 8.4 ± 7.9	(2-53) 8.2 ± 7.2	0.831
Pelvic lymph nodes (No.)	(0-61) 26.9 ± 11.5	(3-78) 26.8 ± 12.7	(11-49) 26.8 ± 9.1	0.995
Para-aortic lymph nodes (No.)	(0-19) 3.7 ± 4.1	(0-20) 5.3 ± 7.0	(0-19) 3.7 ± 4.3	0.440
Total lymph nodes (No.)	(0-74) 28.9 ± 13.1	(3-81) 27.6 ± 12.9	(11-55) 28.3 ± 10.2	0.770
Recurrence, No. (%)	14 (9.6%)	6 (7.8%)	2 (3.6%)	0.378
Liver	2	0	0	
Lung	9	0	0	
Brain	0	1	0	
Omentum	0	1	0	
Vaginal stump	1	1	1	
Liver, adrenal glands and bone	0	1	0	
Cul de sac	0	1	0	
Lung, aorta, and pancreas	0	0	1	
Stump, and ureter	1	0	0	
Stump, liver, and omentum	0	1	0	
Pelvic cavity	1	0	0	
Death, No. (%)	7 (4.8)	4 (5.2)	1 (1.8)	0.590

nosed with stage I endometrioid tumors. There were no differences between the non-obese, overweight, and obese patient groups in terms of the proportions of women who required lymphadenectomy (86.8% vs. 93.8% vs. 95.7%, respectively, P = 0.067). Lymphadenectomies had not been performed on 22 of the study patients (11.1%).

There were no significant differences between the non-obese, overweight, and obese groups in terms of the operative time (180.7 vs. 182.8 vs. 184.5 min; P = 0.124), hospital stay (7.9 vs. 8.4 vs. 8.2 days; P = 0.831), EBL (233.3 vs. 244.6 vs. 261.6 mL; P = 0.739), post-operative drop in Hb (1.9 vs. 2.0 vs. 1.9 g/dL; P = 0.748), and the total number of harvested lymph nodes (28.9 vs. 27.6 vs. 28.3; respectively; P = 0.770; Table 3).

The median follow-up time for the non-obese, overweight, and obese patient groups were 71.7 (range, 8.3-152.4), 75.9 (range, 6.3-131.1), and 80.8 months (15.4-139.5) (P = 0.460). In total, the median follow-up time for the 278 patients was 74.1 months (range, 6.3-152.4). The rates of recurrence, death, disease-free survival, and overall survival were similar in the three groups (Fig. 1).

All of the patient groups were similar in terms of their need for intra-operative blood transfusion and the incidences of intra-, post-operative, and long-term complications. There were no complications related to the insertion of the laparoscopic trocars. Among the non-obese patients, two developed intra-operative complications including, respectively, small-bowel
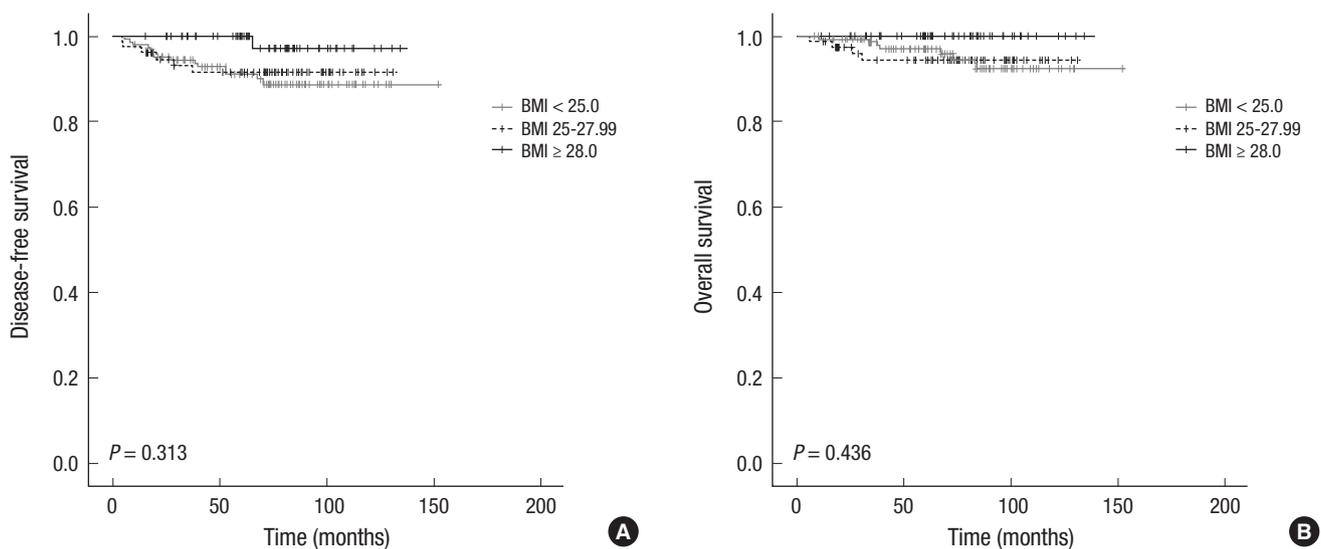

Fig. 1. Survival curves by obesity. (**A**) Disease-free and (**B**) overall survival rates.

Table 4. Intra-operative, short-term, and long-term complications

Complications	No. (%) of patients			P
	BMI < 25 (n = 146)	BMI 25-27.99 (n = 77)	BMI ≥ 28 (n = 55)	
Intra-operative blood transfusion	12 (8.2)	3 (3.9)	1 (1.8)	0.158
Intra-operative complications	2 (1.4)	3 (3.9)	1 (1.8)	0.458
Bladder wall injury	1	1	0	
Conversion to laparotomy	0	1	0	
Small bowel injury	1	0	0	
Left internal iliac vein injury + EBL > 1,000 mL	0	0	1	
EBL > 1,000 mL	0	1	0	
Post-operative complications	12 (8.2)	2 (2.6)	2 (3.6)	0.173
Post-operative blood transfusion	11	2	2	
Obturator neuropathy induced leg weakness	1	0	0	
Long-term complications				0.076
Total	19 (13.0)	19 (24.7)	8 (14.5)	
Lymphedema	8	12	1	
Lymphedema + cellulitis	1	2	3	
Symptomatic lymphocele	5	4	4	
Deep vein thrombosis	2	1	0	
Ovarian vein thrombosis	1	0	0	
Incisional hernia	1	0	0	
Vaginal stump bleeding	1	0	0	

EBL, estimated blood loss.

injury that required bowel repair and bladder wall weakening because of dissection from the uterus with severe adhesion that required reinforcement. Three, overweight women developed intra-operative complications, including, respectively, bladder-wall weakening due to dissection from the uterus that required reinforcement, EBL more than 1,000 mL, and conversion to laparotomy due to cervical stromal invasion by endometrioid and adenosquamous tumors, was all of which were noted on the frozen sections. One obese woman developed intra-operative complications including left, internal, iliac-vein injury that required primary repair with EBL more than 1,000 mL (Table 4).

DISCUSSION

The words, "small" and "lean", have always been used to describe Asian populations, and the prevalence of obesity in Korea, and in Asia in general, is lower than elsewhere in the world. However, the incidence of obesity and related diseases are increasing (23). The incidence of endometrial cancer is also increasing in Korea and in other Asian countries. Women with a high BMI also frequently develop endometrial cancer. Obesity is one of the most important risk factors for the development of type I endometrial carcinoma, particularly in postmenopausal women (26).

Many previous studies have shown that the use of total laparoscopic hysterectomy and laparoscopic-assisted vaginal hysterectomy are associated with a significant decrease in blood loss, the need for transfusions, postoperative pain, and the duration of hospitalization compared with the use of open surgery for the treatment of endometrial cancer (27-31).

In order to minimize the risk of intra- and post-operative complications, a less invasive laparoscopic surgical approach would be helpful in this setting. The role of vaginal surgery is restricted by the need to harvest lymph nodes for complete nodal staging, although it also demonstrates many advantages by reducing

morbidity and the operative time (32).

Since the first report describing the use of laparoscopic surgical staging to assess two patients with clinical stage I endometrial cancer (33), the use of laparoscopic surgery for the management of gynecologic cancer, including endometrial cancer, has increased (34). Many studies have since supported the theory that laparoscopic surgery is feasible for the management of patients with early-stage disease (3-5, 27, 28, 30).

In our study, there were no significant differences between the non-obese, overweight, and obese groups in terms of the operative time, volume of transfused blood, and the EBL. The mean hospital stay of our patients was longer than that reported in other studies, most likely because most Korean patients only want to be discharged after a complete recovery, including the removal of any drainage tubes and stitches and improvement in their general health condition, and the Korean medical insurance system covers this (3).

The no drainage method has been shown to be as effective as the conventional drainage method (35). Patients could probably be discharged sooner by safely removing drainage tubes earlier than several days following their procedure or by completely avoiding the need for drainage tubes. We did not close the retro-peritoneum following laparoscopic lymphadenectomy in order to allow the free flow of lymphatic fluid into the peritoneal space, and thus resulting in a lower incidence of lymphocyst formation.

In our study, there was no difference in terms of the operative time and the rate of transfusion compared to those in previous studies, and our study showed a lower rate of intra- and postoperative complications, a larger number of retrieved lymph nodes, and a better survival outcome after the longest follow-up period (Table 5). Farthing et al. (19) reported a short operative time and low EBL compared to previous studies, including our study. This is probably due to the relatively low rate of lymph-

Table 5. Published data on laparoscopic surgery in obese patients with endometrial cancer

Author (reference)	Year	No.	BMI	EBL (mL)	Operative time	Transfusion	Intra-operative complications	Post-operative complications	Number of LN	Recur	Death	DFS & OS	Median follow-up (months)
Eltabbakh et al. (18)	2000	40	≥ 28	318.2	194.8	0	1 (2.5%)	3 (7.5%)	11.3 (PLN)	-	-	-	-
Eltabbakh et al. (27)	2002	100	28.8 (mean)	200 (median)	-	-	-	9 (9.0%)	11.0 (PLN) & 2.5 (PALN)	7 (7.0%)	4 (4.0%)	90% & 92% (5 yr)	27
Scribner et al. (38)	2002	55	≥ 28	-	-	-	-	-	22.9 (PLN) & 6.6 (PALN)	-	-	-	-
Obermair et al. (37)	2005	47	≥ 100 kg	278.5	139.3	1 (2.1%)	-	-	7.9	2 (4.3%)	-	-	-
Pellegrino et al. (32)	2009	37	≥ 30	188	228	0	0	2 (5.4%)	17 (median)	-	-	-	-
Farthing et al. (19)	2012	61 & 53	30-39.99 & ≥ 40	50 & 50	95 & 75	0	5 (8.2%)	3 (5.6%)	-	6 (8.6%) & 3 (5.7%)	2 (3.44%) & 3 (5.7%)	-	33 & 30
Current series		55	≥ 28	261.6	184.5	1 (1.8%)	1 (1.8%)	2 (3.6%)	26.8 (PLN) & 3.7 (PALN)	2 (3.6%)	1 (1.8%)	96% & 98%	80.8

BMI, body mass index; EBL, estimated blood loss; LN, lymph node; DFS, disease-free survival; OS, overall survival; PLN, pelvic lymph node; PALN, para-aortic lymph node.

adenectomy of 3.1%.

The complication rates observed in the three patient groups in our study were low, which highlights the safety of the surgical approach. Intra-operative complications included injuries to the great vessels, bladder, and bowel serosa. No vascular injuries developed while using the closed method to insert the trocar. One patient developed a vascular injury during a lymphadenectomy. This was repaired by clip ligation, and the patient did not undergo a laparotomy. Other complications were also resolved during surgery, and no conversions to laparotomy were required as a result of the intra-operative complications.

A recent study from an ancillary data analysis of the Gynecologic Oncology Group (GOG) LAP2 also revealed that there was no difference in intra-operative complications in obese patients (14). This indicates that obesity is not an obstacle for performing both open and laparoscopic surgery for endometrial cancer. A higher post-operative complication rate was observed in the higher BMI groups as the frequency of these complications increased significantly at a BMI higher than 30 for the duration of the use of antibiotics, and at 35 for venous thrombophlebitis and wound infection (14). The etiology of the difference in post-operative complications between Western studies and our study might be due to the fact that Korean patients are less obese compared to those patients in Western studies. However, the mean BMI of the obese group in our study was 30.9 with a range of 28 to 42.2, and which was also sufficiently 'obese' for the Western criteria. In addition, the aim of the study based on ancillary data of GOG LAP2 was to investigate the association of obesity on complications, recurrence, and survival outcome in endometrial cancer patients regardless of the type of surgery rather than investigating the surgical feasibility and survival outcome of laparoscopic surgery, as in our study (14). Increasing BMI did not impact the rate of post-operative complications of laparoscopy in another Western study (21). This indicates that not only the severity of obesity, itself, but also the difference in patient characteristics in terms of diet, socio-behavior patterns, ethnic group, and differences in study design should be considered and investigated for determining the differences in surgical and survival outcomes.

There are few reports regarding the feasibility of laparoscopic surgery in obese Korean women. To our knowledge, ours is the first study regarding the surgical feasibility and safety of laparoscopic surgery for treating endometrial cancer in obese Korean women. In our study, laparoscopic surgery was feasible in terms of the intra- and post-operative complications, such as one of the previous reports of GOG LAP2 study data which compared laparoscopy with laparotomy for comprehensive surgical staging of endometrial cancer (36).

The rate of conversion to laparotomy in laparoscopic surgery was 1.04% to 10.6% in previous studies (18, 19, 27, 37). In contrast, Walker et al. (36) and Scribner et al. (38) reported the con-

version rate in their studies as 25.8% and 36.4%, respectively. In our study, there was only one case of conversion in the overweight group and thus with a rate of 1.3%. Walker et al. (36) revealed that conversion to laparotomy is associated with obesity, metastatic disease, and increasing age. In our study, the rate of extra-uterine spread was lower and the mean age was younger than that of the GOG LAP2 data. However, the mean BMI of the obese group in our study was higher than the GOG LAP2 data, indicating that the reason for the difference in conversion rate between the two studies should be considered with other factors including the rate of metastatic disease and patient age rather than only obesity itself. The surgeon's preference and clinical experience as well the conventions of medical institutions should be considered, although these are difficult to quantify.

We assume that the most important factor is the difference in the rate of pelvic and/or para-aortic lymphadenectomy. Walker et al. reported that 98.3% of their patients underwent lymphadenectomy and 91.9% underwent para-aortic lymphadenectomy, and Scribner et al. reported the utility of laparoscopy in lymphadenectomy and all patients in this study underwent pelvic and para-aortic lymphadenectomy (36, 38). In contrast, Farthing et al. (19) performed lymphadenectomy in 3.1% of all of their patients. Eltabbakh et al. performed pelvic lymphadenectomy in 77.5% of their patients and para-aortic lymphadenectomy in 17.5% of the patients in his earlier study, and with 75.7% for pelvic and 21.1% for para-aortic lymphadenectomy in his later study, while Obermair et al. performed lymphadenectomy in 67.8% of their patients (18, 27, 37). In our study, 98.8% and 95.7%, respectively, underwent lymphadenectomy, and 26.8% and 31.4% underwent para-aortic lymphadenectomy in the overweight group and the obese group.

Giugale et al. reported that an increasing BMI in laparoscopic surgery patients decreases the frequency of lymphadenectomy and the number of harvested para-aortic lymph nodes with 4.6 in the obese group with a BMI of 30-39 and 2.2 in the morbidly obese group with a BMI of 40-49 (39). Helm et al. (21) also reported that the performance of para-aortic and pelvic lymphadenectomy had an inverse relationship with an increasing BMI, although an increasing BMI did not impact the number of para-aortic and pelvic lymph nodes removed. Scribner et al. and Eltabbakh et al. harvested 6.6 and 2.5 para-aortic lymph nodes in their studies (27, 38). In our study, 5.3 and 3.7 para-aortic lymph nodes were harvested in the overweight group and the obese group, respectively, and which seems to have no significant difference compared to previous studies.

Although not statistically significant, the obese group showed less recurrence and death in our study. The association between obesity and the prognosis of endometrial cancer remains controversial. Previous studies have suggested that obesity is associated with a worse prognosis, while there no relationship seen in other studies (10-13). Gunderson et al. (14) recently reported

that a high BMI was not associated with the patient survival outcome, but showed a lower recurrence although not of statistical significance. This is probably because an increasing BMI shows a lower FIGO stage, a higher proportion of well-differentiated endometrioid type tumors, and a lower risk factor for recurrence such as lymph node/ovarian metastasis, as well as positive cytology as defined by Keys et al. in GOG 99 (14, 40). Also in a previous Korean population study, overweight and obese women had an earlier FIGO stage with less cervical extension and positive peritoneal cytology (13).

As seen in previous studies, there were no significant differences from our study in terms of the disease-free and overall survival rates in our three patient groups. It indicates, therefore, that the use of laparoscopic surgery to manage obese patients has no appreciable impact on their prognosis (22).

The limitation of our study is its retrospective design and the possibility of a selection bias as most of the laparoscopic surgeries were chosen by the patient and/or surgeon based on their preference and decision, although there was no difference in the patient characteristics in the three groups. At the same time, this is the largest Korean study to date to directly investigate the surgical and survival outcomes of obese Korean patients with endometrial cancer who underwent laparoscopic surgery during such a long study period. In conclusion, our findings indicate that laparoscopic surgery is a safe and feasible procedure for managing obese, Korean, early-stage endometrial carcinoma patients and does not appear to affect the prognosis in these cases. Large, randomized, prospective, multi-center studies regarding the safety and feasibility of laparoscopic surgery for the management of obese Korean women with early endometrial carcinoma are still needed.

DISCLOSURE

The authors declare that they have no conflicts of interest to report.

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REFERENCES

1. Jemal A, Siegel R, Ward E, Murray T, Xu J, Smigal C, Thun MJ. *Cancer statistics, 2006. CA Cancer J Clin 2006; 56: 106-30.*
2. Bristow RE. *Endometrial cancer. Curr Opin Oncol 1999; 11: 388-93.*
3. Kim DY, Kim MK, Kim JH, Suh DS, Kim YM, Kim YT, Mok JE, Nam JH. *Laparoscopic-assisted vaginal hysterectomy versus abdominal hysterectomy in patients with stage I and II endometrial cancer. Int J Gynecol Cancer 2005; 15: 932-7.*

4. Malur S, Possover M, Michels W, Schneider A. *Laparoscopic-assisted vaginal versus abdominal surgery in patients with endometrial cancer-a prospective randomized trial. Gynecol Oncol 2001; 80: 239-44.*
5. Eltabbakh GH, Shamonki MI, Moody JM, Garafano LL. *Laparoscopy as the primary modality for the treatment of women with endometrial carcinoma. Cancer 2001; 91: 378-87.*
6. Anderson B, Connor JP, Andrews JI, Davis CS, Buller RE, Sorosky JI, Benda JA. *Obesity and prognosis in endometrial cancer. Am J Obstet Gynecol 1996; 174: 1171-8; discussion 8-9.*
7. Hachisuga T, Fukuda K, Hirakawa T, Kawarabayashi T. *The effect of nulliparity on survival in endometrial cancer at different ages. Gynecol Oncol 2001; 82: 122-6.*
8. Bergström A, Pisani P, Tenet V, Wolk A, Adami HO. *Overweight as an avoidable cause of cancer in Europe. Int J Cancer 2001; 91: 421-30.*
9. Coleman MP, Estève J, Damiecki P, Arslan A, Renard H. *Trends in cancer incidence and mortality. IARC Sci Publ 1993; (121): 1-806.*
10. Arem H, Chlebowski R, Stefanick ML, Anderson G, Wactawski-Wende J, Sims S, Gunter MJ, Irwin ML. *Body mass index, physical activity, and survival after endometrial cancer diagnosis: results from the Women's Health Initiative. Gynecol Oncol 2013; 128: 181-6.*
11. Mauland KK, Trovik J, Wik E, Raeder MB, Njolstad TS, Stefansson IM, Oyan AM, Kalland KH, Bjorge T, Akslen LA, et al. *High BMI is significantly associated with positive progesterone receptor status and clinicopathological markers for non-aggressive disease in endometrial cancer. Br J Cancer 2011; 104: 921-6.*
12. Münstedt K, Wagner M, Kullmer U, Hackethal A, Franke FE. *Influence of body mass index on prognosis in gynecological malignancies. Cancer Causes Control 2008; 19: 909-16.*
13. Jeong NH, Lee JM, Lee JK, Kim JW, Cho CH, Kim SM, Seo SS, Park CY, Kim KT, Lee J. *Role of body mass index as a risk and prognostic factor of endometrioid uterine cancer in Korean women. Gynecol Oncol 2010; 118: 24-8.*
14. Gunderson CC, Java J, Moore KN, Walker JL. *The impact of obesity on surgical staging, complications, and survival with uterine cancer: a Gynecologic Oncology Group LAP2 ancillary data study. Gynecol Oncol 2014; 133: 23-7.*
15. Bijen CB, de Bock GH, Vermeulen KM, Arts HJ, ter Brugge HG, van der Sijde R, Kraayenbrink AA, Bongers MY, van der Zee AG, Mourits MJ. *Laparoscopic hysterectomy is preferred over laparotomy in early endometrial cancer patients, however not cost effective in the very obese. Eur J Cancer 2011; 47: 2158-65.*
16. Childers JM, Brzechffa PR, Hatch KD, Surwit EA. *Laparoscopically assisted surgical staging (LASS) of endometrial cancer. Gynecol Oncol 1993; 51: 33-8.*
17. O'Hanlan KA, Lopez L, Dibble SL, Garnier AC, Huang GS, Leuchtenberger M. *Total laparoscopic hysterectomy: body mass index and outcomes. Obstet Gynecol 2003; 102: 1384-92.*
18. Eltabbakh GH, Shamonki MI, Moody JM, Garafano LL. *Hysterectomy for obese women with endometrial cancer: laparoscopy or laparotomy? Gynecol Oncol 2000; 78: 329-35.*
19. Farthing A, Chatterjee J, Joglekar-Pai P, Dorney E, Ghaem-Maghami S. *Total laparoscopic hysterectomy for early stage endometrial cancer in obese and morbidly obese women. J Obstet Gynaecol 2012; 32: 580-4.*
20. Heinberg EM, Crawford BL 3rd, Weitzen SH, Bonilla DJ. *Total laparoscopic hysterectomy in obese versus nonobese patients. Obstet Gynecol*

2004; 103: 674-80.

21. Helm CW, Arumugam C, Gordinier ME, Metzinger DS, Pan J, Rai SN. *Laparoscopic surgery for endometrial cancer: increasing body mass index does not impact postoperative complications. J Gynecol Oncol 2011;* 22: 168-76.

22. Walker JL, Piedmonte MR, Spirtos NM, Eisenkop SM, Schlaerth JB, Mannel RS, Barakat R, Pearl ML, Sharma SK. *Recurrence and survival after random assignment to laparoscopy versus laparotomy for comprehensive surgical staging of uterine cancer: Gynecologic Oncology Group LAP2 Study. J Clin Oncol 2012; 30: 695-700.*

23. Weisell RC. *Body mass index as an indicator of obesity. Asia Pac J Clin Nutr 2002; 11 Suppl 8: S681-4.*

24. Kim SH, Hong SB, Suh YJ, Choi YJ, Nam M, Lee HW, Park Ie B, Chon S, Woo JT, Baik SH, et al. *Association between nutrient intake and obesity in type 2 diabetic patients from the Korean National Diabetes Program: a cross-sectional study. J Korean Med Sci 2012; 27: 1188-95.*

25. Creasman W. *Revised FIGO staging for carcinoma of the endometrium. Int J Gynaecol Obstet 2009; 105: 109.*

26. Shoff SM, Newcomb PA. *Diabetes, body size, and risk of endometrial cancer. Am J Epidemiol 1998; 148: 234-40.*

27. Eltabbakh GH. *Analysis of survival after laparoscopy in women with endometrial carcinoma. Cancer 2002; 95: 1894-901.*

28. Gemignani ML, Curtin JP, Zelmanovich J, Patel DA, Venkatraman E, Barakat RR. *Laparoscopic-assisted vaginal hysterectomy for endometrial cancer: clinical outcomes and hospital charges. Gynecol Oncol 1999; 73: 5-11.*

29. Holub Z. *The role of laparoscopy in the surgical treatment of endometrial cancer. Clin Exp Obstet Gynecol 2003; 30: 7-12.*

30. Magrina JF, Mutone NF, Weaver AL, Magtibay PM, Fowler RS, Cornella JL. *Laparoscopic lymphadenectomy and vaginal or laparoscopic hysterectomy with bilateral salpingo-oophorectomy for endometrial cancer: morbidity and survival. Am J Obstet Gynecol 1999; 181: 376-81.*

31. Zullo F, Palomba S, Russo T, Falbo A, Costantino M, Tolino A, Zupi E, Tagliaferri P, Venuta S. *A prospective randomized comparison between laparoscopic and laparotomic approaches in women with early stage endometrial cancer: a focus on the quality of life. Am J Obstet Gynecol*

2005; 193: 1344-52.

32. Pellegrino A, Signorelli M, Fruscio R, Villa A, Buda A, Beretta P, Garbi A, Vitobello D. *Feasibility and morbidity of total laparoscopic radical hysterectomy with or without pelvic limphadenectomy in obese women with stage I endometrial cancer. Arch Gynecol Obstet 2009; 279: 655-60.*

33. Childers JM, Surwit EA. *Combined laparoscopic and vaginal surgery for the management of two cases of stage I endometrial cancer. Gynecol Oncol 1992; 45: 46-51.*

34. Cho YH, Kim DY, Kim JH, Kim YM, Kim YT, Nam JH. *Laparoscopic management of early uterine cancer: 10-year experience in Asan Medical Center. Gynecol Oncol 2007; 106: 585-90.*

35. Bafna UD, Umadevi K, Savitha M. *Closed suction drainage versus no drainage following pelvic lymphadenectomy for gynecological malignancies. Int J Gynecol Cancer 2001; 11: 143-6.*

36. Walker JL, Piedmonte MR, Spirtos NM, Eisenkop SM, Schlaerth JB, Mannel RS, Spiegel G, Barakat R, Pearl ML, Sharma SK. *Laparoscopy compared with laparotomy for comprehensive surgical staging of uterine cancer: Gynecologic Oncology Group Study LAP2. J Clin Oncol 2009; 27: 5331-6.*

37. Obermair A, Manolitsas TP, Leung Y, Hammond IG, McCartney AJ. *Total laparoscopic hysterectomy versus total abdominal hysterectomy for obese women with endometrial cancer. Int J Gynecol Cancer 2005; 15: 319-24.*

38. Scribner DR Jr, Walker JL, Johnson GA, McMeekin DS, Gold MA, Mannel RS. *Laparoscopic pelvic and paraaortic lymph node dissection in the obese. Gynecol Oncol 2002; 84: 426-30.*

39. Giugale LE, Di Santo N, Smolkin ME, Havrilesky LJ, Modesitt SC. *Beyond mere obesity: effect of increasing obesity classifications on hysterectomy outcomes for uterine cancer/hyperplasia. Gynecol Oncol 2012; 127: 326-31.*

40. Keys HM, Roberts JA, Brunetto VL, Zaino RJ, Spirtos NM, Bloss JD, Pearlman A, Maiman MA, Bell JG. *A phase III trial of surgery with or without adjunctive external pelvic radiation therapy in intermediate risk endometrial adenocarcinoma: a Gynecologic Oncology Group study. Gynecol Oncol 2004; 92: 744-51.*