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# Influence of Morbid Obesity on Surgical Outcomes in Robotic-Assisted Gynecologic Surgery

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## Abstract

***Objective:*** The aim of this research was to estimate the impact of body mass index (BMI) on surgical outcomes in patients undergoing robotic-assisted gynecologic surgery. ***Materials and Methods:*** This study was a retrospective review of prospectively collected cohort data for a consecutive series of patients undergoing gynecologic robotic surgery in a single institution. BMI, expressed as kg/m$^2$, was abstracted from the medical charts of all patients undergoing robotic hysterectomy. Data on estimated blood loss (EBL), hemoglobin (Hb) drop, procedure time, length of hospital stay, uterine weight, pain-medication use, and complications were also extracted. ***Results:*** Two hundred and eighty-one patients underwent robotic operations. Types of procedures were total hysterectomy with or without adnexal excision, and total hysterectomies with lymphadenectomies. Eighty-four patients who were classified as morbidly obese (BMI > 35) were compared with 197 patients who had a BMI of < 35 (nonmorbidly obese). For patients with BMI < 35, and BMI > 35, the mean BMI was 27.1 and 42.5 kg/m$^2$ ($p < 0.05$), mean age was 49 and 50 ($p = 0.45$), mean total operative time was 222 and 266 minutes ($p < 0.05$), console time 115 and 142 minutes ($p < 0.05$), closing time (from undocking until port-site fascia closure) was 30 and 41 minutes ($p < 0.05$), EBL was 67 and 79 mL ($p = 0.27$), Hb drop was 1.6 and 1.4 ($p = 0.28$), uterine weight was 196.2 and 227 g ($p = 0.52$), pain-medication use 93.7 and 111 mg of morphine ($p = 0.46$), and mean length of stay was 1.42 and 1.43 days (0.9), all respectively. No statistically significant difference was noted between the 2 groups for EBL, Hb drop, LOS, uterine weight, pain-medication use, or complications. The only statistically significant difference was seen in operating times and included docking, console, closing, and procedure times. There were no perioperative mortalities. Morbidity occurred in 24 patients (8%). In the morbidly obese group, there were 6 complications (7%) and, in the nonmorbidly obese group, there were 18 complications (9%). ***Conclusions:*** Morbid obesity does not appear to be associated with an increased risk of morbidity in patients undergoing robotically assisted gynecologic surgery. Morbid obesity is associated with increased procedure time, but otherwise appears to have no difference in outcomes. Robotic surgery offered an ideal approach, allowing minimally invasive surgery in these technically challenging patients, with no significant increase in morbidity. J GYNECOL SURG 30:81)

## Introduction

Obesity has become a national epidemic, with an estimated 64% of Americans being overweight and more than one-third of U.S. adults (35.7%) being obese.[1–3] Obesity increases the risk of a number of health conditions, including hypertension, adverse lipid concentrations, and type 2 diabetes. The prevalence of obesity among women in the United States presents a growing challenge for all physicians. More specifically, obesity in the United States has a profound impact on gynecologic patients, is associated with greater risk of ovulatory dysfunction, pelvic-organ prolapse, and has also been shown to cause an increased risk of endometrial polyps, symptomatic fibroids, endometrial hyperplasia, endometrial cancer, and breast cancer.[4]

Elevated body mass index (BMI) has been thought to be associated with poorer surgical outcomes, especially after procedures of increased technical complexity. Obese patients

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are more likely to present with comorbid medical conditions, particularly cardiovascular and respiratory diseases, conferring an increased morbidity and early mortality rate, compared to the general population. There is clear evidence that obesity is a risk factor for developing gynecologic cancers, mainly endometrial cancer. Minimally invasive surgical methods are becoming more common for treating endometrial cancer. However, there has been some reporting of limited use of such methods because technical limitations, long learning curves, long operation durations, and considerations of safety issues. In obese patients, peritoneal-cavity access may be more difficult, and there is suboptimal peritoneal distension, and reduced vision and operating freedom for the surgeon. The introduction of the robotic system has helped to overcome the technical limitations of laparoscopy by simplifying the procedures. Gehrig et al. reported that robotic surgery is associated with improved lymph-node count, reduced EBL, shorter operative times, and diminished hospital stays, compared to a total laparoscopic hysterectomy group.[5] Göçmen et al, also showed a decrease in operative time, hospital stay, estimated blood loss, and complications when comparing laparoscopic surgery for endometrial cancer staging to robotic surgery.[6]

In the gynecology literature, there are an insufficient number of studies that have evaluated the impact of obesity on robotic surgery. Most of these compare laparoscopy[7] or laparotomy[8] with robotic surgery in the obese patient, which introduces many other potential biases in analyses related to the type of procedure. Therefore, the current authors sought to evaluate the difference in outcomes between morbidly obese and nonmorbidly obese patients undergoing robotic-assisted gynecologic surgery, for both benign and oncology procedures.

## Materials and Methods

This was an institutional review board–approved retrospective review of prospectively collected data in a consecutive series of robotic-assisted gynecologic surgeries in a single institution. Approximately 10 surgeons with different experience levels performed these surgeries. Of these surgeons, 1 had prior experience at another institution and the remaining surgeons were all beginners and had no prior experience. Thus, the majority of cases in this cohort consisted of surgeons in the early part of their learning curves. All robotic surgeries were performed with the da Vinci Surgical System (Intuitive Surgical, Sunnydale, CA) using a four-arm robot. The study population included a consecutive series of robot-assisted gynecologic surgery patients between May 2010 and March 2012.

The classification endorsed by the National Institutes of Health and the World Health Organization, defines *obesity* as a BMI of $>30$ kg/m$^2$. Obesity class 1 is a BMI of 30–34.9, class II is a BMI of 35–39.9, and class III is a BMI $>40$ kg/m$^2$. In the current study, it was decided to use Class II as the cutoff for comparison. The rationale for this decision was that the wide prevalence of class I obesity has fairly become the norm in the region being studied. In addition, the current authors have experienced more difficulty when positioning patients in the operating room with class II obesity patients.

Two hundred and eighty-one patients underwent robotic gynecologic operations. The types of procedures were total hysterectomy with or without adnexal excision (RAH ± BSO), and hysterectomies with lymphadenectomies, with or without adnexal excision (RAH + LND ± BSO). The patients were grouped and analyzed into three groups based on type of procedure performed. Group 1 (Table 1) was (RAH ± BSO), group 2 (Table 2) was (RAH + LND ± BSO) and group 3 (Table 3) included both groups 1 and 2. In each group, the patients with a BMI of $>35$ (morbidly obese) were compared with patients with a BMI $<35$, in terms of perioperative variables and outcomes. Patient characteristics such as age and BMI were collected. BMI is calculated as weight (kg)/[height (m)]$^2$, and the cutoff used for comparison was morbidly obese (BMI $>35$), compared to

Table 1. Perioperative Variables in RAH ± BSO Patients

| *Variable* | *BMI < 35* | *BMI > 35* | p-*Value* |
|---|---|---|---|
| *N* | 169 | 67 | |
| Age | 47.07 | 48.2 | 0.4 |
| BMI | 27.1 | 42.9 | < 0.05 |
| EBL | 72.1 | 79.7 | 0.55 |
| Hb drop | 1.77 | 1.46 | 0.09 |
| LOS | 1.36 | 1.36 | 0.98 |
| ut wt | 201.5 | 256.8 | 0.41 |
| Time to dock | 27.2 | 31.96 | < 0.04 |
| Console time | 105.7 | 120.6 | < 0.05 |
| Preparation time | 11.1 | 10.3 | 0.46 |
| Closing time | 29.2 | 41.9 | < 0.05 |
| Procedure time | 161.4 | 193.8 | < 0.05 |
| OR time | 211 | 247.8 | < 0.05 |
| Complications | 14 (8%) | 3 (4%) | – |
| Pain medication | 98.5 | 117 | 0.47 |

RAH, robotic-assisted hysterectomy; BSO, bilateral salpingo-ooperectomy; BMI, body mass index, EBL, estimated blood loss, Hb, hemoglobin, LOS, length of stay, ut wt, uterine weight; OR, operating room.

Table 2. Perioperative Variables in RAH/LND Patients

| *Variable* | *BMI < 35* | *BMI > 35* | p-*Value* |
|---|---|---|---|
| *N* | 28 | 17 | |
| Age | 62.3 | 58 | 0.21 |
| BMI | 27.8 | 41.9 | < 0.05 |
| EBL | 26 | 17 | 0.14 |
| Hb drop | 0.7 | 1.3 | 0.17 |
| LOS | 1.74 | 1.7 | 0.91 |
| ut wt | 127.6 | 165.3 | 0.21 |
| Time to dock | 28.6 | 32.4 | 0.48 |
| Console time | 159.3 | 187.8 | 0.17 |
| Preparation time | 10.6 | 12 | 0.55 |
| Closing time | 25 | 17 | 0.25 |
| Procedure time | 226 | 265 | 0.06 |
| OR time | 280.6 | 321.2 | 0.06 |
| Complications | 3 (10%) | 4 (23%) | – |
| Pain medication | 52.5 | 40 | 0.4 |

RAH, robotic-assisted hysterectomy; LND, lymph-node dissection; BMI, body mass index, EBL, estimated blood loss, Hb, hemoglobin, LOS, length of stay, ut wt, uterine weight; OR, operating room.

Table 3. Perioperative Variables in RAH + RAH/LND Patients

| *Variable* | *BMI < 35* | *BMI > 35* | p-*Value* |
|---|---|---|---|
| *N* | 197 | 84 | |
| Age | 49.5 | 50.4 | 0.45 |
| BMI | 27.1 | 42.5 | < 0.05 |
| EBL | 67.6 | 79.3 | 0.27 |
| Hb drop | 1.64 | 1.47 | 0.28 |
| LOS | 1.42 | 1.43 | 0.9 |
| ut wt | 196.2 | 227.7 | 0.52 |
| Time to dock | 26.9 | 32.9 | < 0.05 |
| Console time | 115.1 | 142 | < 0.05 |
| Preparation time | 11.04 | 10.7 | 0.74 |
| Closing time | 30.4 | 41.8 | < 0.05 |
| Procedure time | 172.1 | 215.1 | < 0.05 |
| OR time | 222.4 | 266.8 | < 0.05 |
| Complications | 17 (8%) | 7 (7%) | – |
| Pain medication | 93.7 | 111.2 | 0.46 |

RAH, robotic-assisted hysterectomy; LND, lymph-node dissection; BMI, body mass index, EBL, estimated blood loss, Hb, hemoglobin, LOS, length of stay, ut wt, uterine weight; OR, operating room.

nonmorbidly obese (BMI < 35). Perioperative variables and outcomes were also all prospectively collected. These included estimated blood loss (EBL), hemoglobin (Hb) drop, length of hospital stay (LOS), uterine weight (ut wt), pain-medication use, and complications. All variables were collected prospectively from the operating room (OR) records, and patients' charts. Pain-medication use was standardized among patients by converting all narcotic medications to the dose equivalent in mg of morphine in a 24-hour period. Operative times and duration of each step were also recorded and included: mean total operative time (from patient in OR till patient out of OR); console time; closing time (from undocking till port-site fascia closure); and procedure time (skin incision to dressing). Intraoperative or postoperative complications were considered to be significant and were included in this study. Postoperative complications either occurred prior to discharge or necessitated readmission to the hospital. The complications reported were collected from patient charts and included a hospital-wide electronic query regarding any patients who were readmitted within 30 days after surgery. Data analysis was performed using SAS 9.3 (Cary, NC). Descriptive statistics were initially generated, followed by a statistical analysis with a Student's *t*-test to compare means between two groups. Significance was set at $p < 0.05$.

## Results

In this study, patients were stratified into 3 groups based on the type of procedure performed. The first group included patients that had just undergone robotic hysterectomy with or without adnexectomy (RAH ± bilateral salpingo-oopherectomy [BSO]). The second group (RAH + lymph-node dissection[LND] ± BSO) only included patients that underwent hysterectomy with LND. The third group [(RAH ± BSO) + (RAH + LND ± BSO)] combined all hysterectomy patients with or without lymphadenectomy (groups 1 and 2). Group 1 (RAH ± BSO) had 236 patients (hysterectomies, with or without adnexal excision), and group 2 (RAH + LND ± BSO) had 45 patients (hysterectomies with lymphadenectomies, with or without adnexal excision). Group 3 [(RAH ± BSO) + (RAH + LND ± BSO)] had a total of both, which was 281. Of these 197, patients had a BMI of < 35 were classified as nonmorbidly obese, and 84 patients who were classified as morbidly obese (BMI > 35). In group 3, for patients with a BMI < 35 and a BMI > 35, the mean BMI was 27.1 and 42.5 kg/m$^2$ ($p < 0.05$); the only statistically significant difference was seen in duration of different steps of the surgery: docking; console; closing; procedure; and operating OR times. The mean total operative times were 222 and 266 minutes ($p < 0.05$), console times were 115 and 142 minutes ($p < 0.05$); closing times (from undocking until port-site fascia closure) were 30 and 41 minutes ($p < 0.05$), all respectively.

Overall, the other variables between obese and nonobese patients were similar. There was no difference in EBL, Hb drop, length of stay, pain-medication use, or complications.

There were no perioperative mortalities in this study; however, morbidity occurred in a total of 24 patients (8%). The morbidly obese group appeared to have a smaller percentage of complications, compared to the nonmorbidly obese group. There were 6 complications (7%) in the morbidly obese group, whereas, in the BMI < 35 group there were 18 complications (9%; Table 4). There was one intraoperative conversion in each group. In the nonmorbidly obese group the reason for conversion was to deliver an intact specimen, and in the morbidly obese group the reason for conversion was to address extensive adhesions.

Table 4. Perioperative Complications Following Robotic-Assisted Gynecologic Surgery Among Patients with BMI < 35 and BMI > 35

| *Complication* | *BMI < 35* (n = *197*) *Group 1* | *BMI > 35* (n = *84*) *Group 2* |
|---|---|---|
| Ileus | 2 | 2 |
| Transfusion | 2 | 0 |
| Bladder injury (intraoperative repair) | 1 | 0 |
| Vaginal-cuff dehiscence | 1 | 0 |
| Pelvic abscess | 3 | 0 |
| Respiratory/non–pulmonary embolism | 3 | 0 |
| Pulmonary embolism | 1 | 0 |
| Vaginal bleeding* | 1 | 0 |
| Cellulitis | 1 | 0 |
| Myositis | 0 | 1 |
| Conversion to laparotomy | 1 | 1 |
| Ureter transection* | 1 | 0 |
| Strangulated hernia, postoperative* | 0 | 1 |
| Ureter thermal injury | 0 | 1 |
| Bowel injury* | 1 | 0 |
| **Total (% of total pts)** | **18 (9%)** | **6 (7%)** |
| Readmission | 8 | 3 |
| Return to OR* | 4 | 1 |

*Reasons for return to the OR.
OR, operating room.

Perioperative complications reported also included return to surgery in the perioperative period and readmissions; inherently, an overlap between these groups of complications would be evident. The morbidly obese group had one return to the OR for a case of strangulated umbilical hernia, necessitating a bowel resection, and the nonmorbidly obese group had 4 returns, which included: vaginal-cuff dehiscence, a ureteral transection, a vaginal laceration, and a bowel injury. The reasons for readmission in the morbidly obese group were ileus (2 patients) and the strangulated umbilical hernia (1 patient). In the nonmorbidly obese group, the reasons for readmission were: ileus (2 patients); pelvic abscesses (3 patients); cellulitis (1 patients); ureteral transection (1 patient); and vaginal cuff dehiscence (1 patient).

## Discussion

Robotic surgery has dramatically impacted the percentage of patients that undergo a minimally invasive approach. The benefit of the minimally invasive approach, especially in obese patients, is well-documented; however, because of its steep learning curve and technical difficulties, this approach has been slow to gain acceptance. Benefits of robotic surgery include three-dimensional high-definition visualization, improved surgeon ergonomics, wristed instruments, increased dexterity, and surgical precision. With the recent adoption of the da Vinci Surgical System for robotic surgery, surgeons have been able to overcome many of the limitations of traditional laparoscopy. It has converted the gynecologic oncology practice at the current authors' institution for minimally invasive staging for endometrial cancer from none to almost 100%, within a 2-year time span, since the inception of this hospital's robotics program. For benign procedures at this institution, robotic surgery has also significantly increased use of the minimally invasive approach, but this increase is not as dramatic as that for oncology patients.

An obese patient presents a different set of challenges for a gynecologic surgeon. The urology literature abounds with data that suggest that the robotic approach in obese patients is safe and effective, with acceptable perioperative outcomes.[9,10] However, the study of the impact of obesity on robotic surgery in gynecology has been limited.

The use of robotics in obese gynecologic patients has mostly been described in the gynecologic oncology literature for staging of endometrial cancer. This is because that endometrial cancer is the most common gynecologic malignancy in the Western world and is strongly associated with obesity. Obese women are more likely to develop endometrial carcinoma. Indeed, a study reported that 68% of women with early stage endometrial cancer are obese.[11] In a meta-analysis of 19 prospective studies including $>3{,}000{,}000$ women, each increase in BMI of 5 kg/m2 incurred a significantly increased risk of developing endometrial carcinoma (*RR*, 1.59; 95% confidence interval, 1.50–1.68).[12] This study indicates that the strong linear positive association of BMI with endometrial cancer risk, suggested that any increase in body mass in the female population will increase endometrial cancer incidence.

Most studies using endometrial cancer cohorts have shown that robotic surgery may offer an advantage to laparoscopy and laparotomy in terms of blood loss, transfusion requirements, conversion to laparotomy, operative time, and length of hospital stay.[13] Similarly, other studies were able to show the same benefit even in obese and morbidly obese patients.[7] Lau et al. explored the relationship between BMI and robotic-surgery outcomes of women diagnosed with endometrial cancer and found no significant difference in console time or postoperative complications between the different BMI categories.[14]

Studies investigating the impact of obesity in benign robotic gynecologic surgeries showed no difference in perioperative outcomes or length of surgery in obese patients.[15–17] George et al. reviewed data on 77 patients undergoing robotic myomectomies. Thirty-two patients (41.6%) were obese or morbidly obese ($BMI > 30$). No associations were determined between BMI and LOS, EBL, or procedure duration.[15] In a similar study, Nawfal et al.[16] performed a retrospective review of 135 robotic-assisted hysterectomies at the Henry Ford Health System, looking at perioperative variables, in relation to BMI (23.4% of women were normal weight or less ($BMI < 25$, $n = 31$), 52.7% of women were obese ($BMI > 30$, $n = 70$), and 36 patients (27.1%) were morbidly obese ($BMI \geq 35$). The researchers found that BMI did not correlate with procedure duration, length of stay, or EBL. In addition, BMI was not found to be associated with an increase in complications. Payne et al. completed a collective review of 5 practices, focusing on the impact of uterine size on robotic hysterectomy specifically as it related to morbidity, blood loss, operation time, hospital stay, and complications.[18] The majority of the patients included in that study were obese (38.4% obese, and 22.8% morbidly obese). Uterine weight was the only factor that predicted significantly greater operative time and EBLirrespective of BMI and other patient characteristics. The researchers concluded that, despite the longer operative time, robotically-assisted hysterectomy in women with large uteri could be accomplished with few conversions to abdominal hysterectomy, minimal blood loss, short hospital stay, and a low rate of major and minor complications.[17]

In the analysis of outcomes between nonobese and obese patients undergoing robotic-assisted gynecologic surgery in the current study, the only variable that continued to show a difference between these 2 groups was duration of surgery. This difference reached statistical significance in groups 1 (RAH ± BSO) and 3 [(RAH ± BSO) + (RAH + LND ± BSO)]. However, in group 2 (RAH + LND ± BSO), with the smallest sample size, there was a nonstatistical trend toward longer operating time ($p = 0.06$). This suggests that a statistically significant difference in duration of surgery would be likely if the sample size were to be increased. This needs to be validated further with a larger study. The significant increase in duration of surgery was noted in all steps, and included time to dock, console time, closing time, procedure time, and OR time.

The association between increased BMI and prolonged operative time with robotic-assisted surgery that was found in the current study, although not reproduced in the gynecology literature has been observed before in the urology literature as well.[18–20] One study, by Zilberman et al.,[20] actually aimed to determine which steps of a robotic prostatectomy procedure in particular contributed to the increased operating time. The researchers were able to identify certain parts of the procedure that prolonged total operating time with specific steps (preparation, nerve-sparing dissection, dorsal-vein complex control, anastomosis) responsible for this result. In another study, conducted by Castle et al., on robot assisted-radical prostatectomy, the researchers found that there was a negative impact on operation time and EBL. They also showed an increase of positive margins an obese group.[9] Ahlering et al., explored the impact of obesity on clinical outcomes in robotic prostatectomy, and showed that obese patients did not recover as quickly as their nonobese counterparts, although this did not reach statistical significance.[21] In addition, the researchers showed that obese patients had more complications and returned to baseline urinary and functional status more slowly.[21] However, Butt et al. found that, unlike the previous studies on radical cystectomy, operative time, blood loss, and complication rate did not significantly differ among the ranges in BMI, finding that wider surgical excision is needed in patients with elevated BMI to decrease the rate of positive margins.[22]

The current study was unique in that it compared the morbidly obese and not just the obese, with the rest of the patients. Furthermore, this study evaluated a series of all consecutive hysterectomy patients, including those that underwent lymphadenectomy. The data were analyzed, including all patients together, then the data were stratified, based on whether they underwent staging lymphadenectomy or not. As 65% percent of population in the United States is overweight—and normal-weight patients are becoming more the exception—morbid obesity (BMI > 35) was chosen as the cutoff, instead of just using obesity (BMI > 30) to produce more meaningful results. Further analysis of the specific steps of the procedure that are responsible for the increase in operating time, revealed that all steps contributed to the increase in operating time. In the current authors' initial analysis of a smaller sample population, the only statistically significant difference was seen in procedure time, which was attributed to a difference in fascia closing times, and not actual console times.[23] However, with further evaluation of a larger data set, it became apparent that all steps of the procedure—including the time to dock, console time, closing time, procedure time, and total operative time—were prolonged.

Limitations to the current study include the smaller number of patients in the hysterectomy with lymphadenectomy group, which showed a nonstatistical trend toward longer operating time. A follow-up study with a larger sample size to evaluate this subgroup further is needed. In addition, the patients in the current study included a variety of surgeons—those who were experienced and some who still on an early learning curve. Thus, the results may or may not be applicable to a single-surgeon cohort or to an experienced surgeon cohort. However, the current study results may be more representative of the early stage of adoption of robotic-assisted gynecologic surgery in a community program. Future studies stratifying the outcomes by surgeons and levels of experience may help elucidate this issue.

## Conclusions

The data from this study lead the current authors to suggest that robotic gynecologic surgery for morbidly obese patients is feasible, and these data indicate comparable outcomes for nonmorbidly obese patients. The increased operating time for morbidly obese patients noted in this study needs more investigation to confirm its validity before it is generalized to all obese patients. Future studies in obese patients undergoing robotic gynecologic surgery are needed, especially with the rising rates of morbid obesity in the United States.

## Disclosure Statement

No financial conflicts of interest exist.

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