

High body mass index does not affect outcomes following robotic assisted laparoscopic prostatectomy

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Introduction: Given the anatomic constraints of obese patients, concern exists as to whether robotic assisted laparoscopic prostatectomy (RALP) is appropriate in patients with higher body mass index (BMI). We reviewed a large RALP database to determine if clinical outcomes are related to BMI.

Methods: The records of patients who underwent a RALP from 2003-2009 were reviewed. BMI stratifications were concordant with the Centers for Disease Control (CDC) standards: ≥ 30 , ≥ 25 and < 30 , and < 25 were classified as obese, overweight, and normal weight, respectively. Baseline, perioperative, histopathologic, and functional outcome data were collected.

Results: A total of 1420 patients were identified and BMI information was available for 1112 patients. Median BMI

in the three strata was 23.5 ($n = 270$), 27.3 ($n = 600$), and 32.1 ($n = 242$). There were no significant differences in preoperative prostate specific antigen (PSA), clinical staging, and preoperative Gleason scores. Operating time was 6 minutes longer in the obese ($p < 0.001$) and prostate weight was 8 g greater ($p < 0.001$). Other perioperative factors were similar, including: EBL, pathologic stage and Gleason score and rates of positive surgical margins. The overall incidence of postoperative complications was similar between the three groups. Biochemical recurrence rates were similar among all patients, although there was a trend toward increased recurrence in the obese ($p = 0.09$). Recovery of erectile function and continence was similar regardless of BMI.

Conclusions: RALP is an effective approach to prostatectomy in obese patients as perioperative and functional outcomes are almost identical across BMI strata. This supports the continued utilization of RALP in obese and overweight men.

Key Words: radical prostatectomy, neoplasm, prostate, obesity, robotics

Introduction

Obesity has been implicated as a major cause of morbidity and mortality.¹ An increased prevalence of diabetes, cancer, cardiovascular, and other chronic diseases are significant public health concerns. For surgeons, obesity imposes a more obvious set of constraints. These include

operative challenges due to anatomical distortion, fatty dissection planes and an increased depth of the operative field. Such intraoperative difficulties are associated with increased rates of surgical complications and worse oncologic outcomes, particularly in the setting of prostate cancer.²⁻⁴

The impact of obesity on the surgical outcomes during prostatectomy has been an area of active research. In particular, the impact of body weight on perioperative, histopathologic, and oncologic prostatectomy outcomes have been described. Increased body mass index (BMI) has correlated with higher rates of blood loss, prostatic capsule incision, positive surgical margins, and

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operative time in the setting of open radical retropubic prostatectomy.⁵⁻⁷ Obese men appear to have a higher risk of biological progression after surgery and are at higher risk of cancer-specific mortality.^{3,8}

The widespread adoption of the robotic assisted laparoscopic prostatectomy (RALP) has led to a re-evaluation of the concerns regarding body habitus as it relates to the surgical complexity of prostatectomy. Some have suggested that anatomical constraints such as a narrow pelvis and limited abdominal access may adversely impact surgical outcomes in the overweight and obese.⁹⁻¹⁰ Supporting this concern are the consistent reports of longer operating time and higher EBL in the obese compared to normal weight patients undergoing RALP.¹¹ More importantly, there have been reports of higher rates of positive surgical margins (PSMs) at all anatomic locations in the obese.^{9,12} However, as most male abdominal adiposity is outside the abdominal cavity, some have argued that prostatectomy via a laparoscopic approach is no more difficult in obese patients than in normal weight patients. Accordingly, EBL and operating time differences have been small and other reports show no difference in PSM rates.¹⁰ Given the conflicting reports of positive surgical margin rates and cancer recurrence in the obese following prostatectomy, this trend is of particular concern and warrants further investigation.

To help evaluate these issues, we reviewed the RALP experience of a single, high-volume surgeon (DBS) to determine the impact of BMI on perioperative, oncologic and functional outcomes.

Methods:

A prospective, institutional review board approved database comprised of all patients undergoing RALP by a single surgeon (DBS) is maintained by research staff at the Mount Sinai Medical Center. Patients undergoing RALP from the initiation of the surgeon's series in January 2003 until August 2009 formed the base population for the current analyses ($n = 1420$). Data on 308 patients were incomplete and these patients were excluded from the analyses. After these exclusions, completed data were available for 1112 patients. The study was thus a retrospective analysis of a prospective database.

BMI stratifications were concordant with the Centers for Disease Control (CDC) standards: ≥ 30 , ≥ 25 and < 30 , and < 25 were classified as obese, overweight, and normal weight, respectively.¹³

Functional outcomes and PSA were collected at baseline, 6 weeks, and then every 3 months for the first year after surgery using International Prostate Symptom Scores (IPSS) and Sexual Health Inventory for Men

(SHIM) scores. Potency was defined as a SHIM ≥ 16 with or without the use of phosphodiesterase-5 inhibitors in patients who were preoperatively potent (SHIM ≥ 16). Urinary continence was evaluated by asking the patients the following question: "How many pads do you require per day?" Patients responding that they require more than one pad per day were categorized as incontinent. Functional outcomes were monitored and collected by the surgeon and research staff. A postoperative PSA ≥ 0.2 ng/mL at least 6 weeks following surgery was considered a biochemical recurrence. Volume of cancer was estimated based on the percentage of slides containing tumor (the positive-block ratio).¹⁴ Tumor at the inked resection margin was considered a positive surgical margin (PSM). PSM were dichotomized into "focal" or "extensive" if the length of the margin was less than or greater than 2 mm, respectively, and their locations recorded. Operative time was the length of time from skin incision to skin closure. Additionally, length of hospital stay and other surgical outcomes such as rates of deep venous thrombosis, pulmonary embolism, incisional hernias, bladder neck contractures, urinary tract infections, ileus, and pelvic fluid collections, were collected.

Comparisons between BMI groups were performed using ANOVA and Chi-square analysis for the trend for continuous and categorical variables, respectively. Data were analyzed with SPSS version 17.0.

Results

Preoperative and demographic data

Table 1 lists the baseline demographics of the groups stratified by BMI. Median patient age was 61, 60, and 59 for the normal weight, overweight, and obese groups, respectively. Median BMI within each group was 23.5, 27.3, and 32.1 ($p < 0.001$), and median preoperative PSA values ranged from 5.0 ng/mL -5.2 ng/mL ($p = 0.86$). The distribution of preoperative clinical staging and total Gleason scores were similar between the three groups.

Perioperative and histopathologic pathologic outcomes

As shown in Table 2, mean operative time was 5 and 6 minutes longer for obese patients as compared to overweight and normal weight patients, respectively ($p < 0.001$). Operative times were stable over the study period in all three BMI groups. EBL was similar between the groups. Specimen weights were greater with increasing BMI, ranging from 48 g in the normal weight group to 56 g in the obese group ($p < 0.001$) however the tumor volume as a fraction of the total prostate

TABLE 1. Demographic and preoperative data for patients included in this study

	Normal weight BMI < 25	Overweight BMI > 25 and < 30	Obese BMI > 30	Significance (p value)
Number of procedures (n)	270	600	242	
Demographic and preoperative data				
Age (median)	61	60	59	0.004
BMI (median)	23.5	27.3	32.1	< 0.001
Preoperative PSA (ng/dL, median)	5.0	5.0	5.2	0.86
Clinical stage				
cT1	211 (84.4%)	441 (85.8%)	191 (88.4%)	0.45
cT2	39 (15.6%)	73 (14.2%)	25 (11.6%)	
Preoperative Gleason score sum				
≤ 6	150 (55.6%)	344 (57.3%)	135 (57.2%)	0.97
7	99 (36.7%)	216 (36.0%)	83 (35.2%)	
≥ 8	21 (7.8%)	40 (6.7%)	18 (7.6%)	

specimen size was comparable between the groups. The distribution of pathologic stages was similar in all three groups, with approximately 19% in each group with locally advanced disease (pT3 or pT4). Similarly, rates of seminal vesicle invasion and extracapsular extension were comparable. The typical Gleason upgrading was seen, but this trend was consistent in all groups and the groups had similar histopathologic Gleason scores. There were no differences in the rates of positive margins between any of the groups ($p = 0.94$). This is true for overall, and length and site specific incidence of positive surgical margins. A small difference in length of hospital stay was seen, as obese patients were hospitalized for 1.17 days after surgery compared to 1.25 days for overweight and normal patients ($p = 0.05$).

Table 3 presents the postoperative complications and functional outcomes for patients in this study. Overweight patients (BMI ≥ 25 and < 30) were more likely to develop pelvic fluid collections/abscesses ($p = 0.05$) and less likely to experience a UTI ($p = 0.04$). There were no significant differences the incidence of incisional hernia, deep venous thrombosis, pulmonary embolism, postoperative ileus, and bladder neck contracture. Additionally, there were no differences in the overall incidence of complications between the three cohorts ($p = 0.90$).

Functional and biochemical outcomes

Data on erectile function and urinary continence were available at 3 month, 6 month, and 12 month follow up visits, Table 3. There were no differences in the

recovery rates of erectile function at the three time intervals, respectively. Urinary continence recovery rates were similar between the three groups.

Median follow up for assessment of biochemical recurrence was approximately 12 months in the three groups, with a range from 1 to 75 months. There were no significant differences in biochemical recurrence rates, however there was a trend toward increasing recurrence with increasing BMI, 3.0% in normal weight patients versus 7.2% in obese patients ($p = 0.09$).

Discussion

Our data suggest that clinical and pathological outcomes are comparable in patients regardless of BMI categorization. Nearly all baseline, operative, pathological, and functional characteristics were similar between the three BMI groups. Although the difference in operative time was statistically significantly, the 6 minute disparity between normal weight and obese patients is of minimal clinical significance.

The incidence of positive surgical margins (PSMs) has been of concern in obese patients undergoing prostatectomy.¹⁵ A review of the Shared Equal Access Regional Cancer Hospital (SEARCH) database of open prostatectomies performed between 1989 and 2002 demonstrated increased risk of PSMs in obese patients. However, with PSM rates of approximately 40% in all groups, all patients were more likely to experience PSMs than patients in our series. Similarly,

TABLE 2. Perioperative and pathologic outcomes for patients in this study

	Normal weight BMI < 25	Overweight BMI > 25 and < 30	Obese BMI > 30	Significance (p value)
Number of procedures (n)	270	600	242	
Perioperative and pathology data				
Operating time (m, median)	121	122	126	< 0.001
EBL (mL, median)	50	50	75	0.32
Specimen weight (g, median)	48	53	56	< 0.001
Tumor volume/specimen volume (%, median)	36	38	38	0.73
Pathologic stage				
pT2a	31 (11.3%)	69 (11.6%)	23 (9.5%)	0.60
pT2b	6 (2.2%)	18 (3.0%)	2 (0.8%)	
pT2c	188 (68.6%)	390 (65.5%)	169 (69.8%)	
pT3a	32 (11.7%)	84 (14.1%)	32 (13.2%)	
pT3b	13 (4.7%)	30 (5.0%)	15 (6.2%)	
pT4	4 (1.5%)	4 (0.7%)	1 (0.4%)	
Postoperative Gleason score sum				
≤ 6	83 (30.7%)	174 (29.2%)	68 (28.1%)	0.88
7	174 (64.4%)	384 (64.4%)	160 (66.1%)	
≥ 8	13 (4.8%)	38 (6.4%)	14 (5.8%)	
Seminal vesicle invasion				
Yes	13 (4.8%)	30 (5.1%)	15 (6.2%)	0.74
No	257 (95.5%)	566 (95.3%)	227 (93.8%)	
Extracapsular extension				
Yes	45 (16.7%)	113 (19.0%)	45 (18.6%)	0.70
No	225 (83.3%)	481 (81.0%)	197 (81.4%)	
Positive margins				
< 2 mm	28 (10.4%)	66 (11.0%)	24 (9.9%)	0.94
≥ 2 mm	15 (5.6%)	40 (6.7%)	17 (7.0%)	
No	227 (84.1%)	494 (82.3%)	201 (83.1%)	

Castle et al report higher overall incidence of positive surgical margins in a small sample of obese patients undergoing RALP.¹² However, our data are consistent with several studies that report a comparable incidence of overall recurrence with no statistically significant differences between BMI strata.¹⁶⁻¹⁷

Our study was remarkable for larger prostate size in obese compared to normal weight patients. This has previously been reported and may be related to abdominal obesity and hormonal levels, although a precise pathophysiologic explanation is lacking.¹⁸ As larger prostate size has been reported to be inversely correlated with positive margin risk after RALP, it is possible that the increased prostate size in our obese patients may have played a role in the equivalent rates of PSMs.¹⁹

Additionally, tumor volume has been reported to be larger in obese as compared to normal weight men. In a study of nearly 3000 prostatectomies from 1988-2007, Freedland et al reported a strongly significant relationship between tumor size and obesity.²⁰ They also reported that the ratio of prostatic involvement was greater in obese men. Our study demonstrated larger prostate size in the obese but a constant ratio of tumor size to prostate size as determined by the block ratio method.

Our data revealed no difference in pathologic Gleason sums in obese patients. There is a discrepancy in the literature regarding this issue. Almost all of the publications that have demonstrated higher pathologic Gleason scores in the obese have included patients diagnosed prior to the PSA era.^{7,15,20,24-27} In contrast,

TABLE 3. Postoperative, functional, and oncologic outcomes for patients included in this series

	Normal weight BMI < 25	Overweight BMI > 25 and < 30	Obese BMI > 30	Significance (p value)
Number of procedures (n)	270	600	242	
Surgical outcomes				
Length of stay (days after surgery, mean)	1.25	1.25	1.17	0.05
Complications				
Incisional hernia	3 (1.1%)	2 (0.3%)	0 (0.0%)	0.14
Deep venous thrombosis	1 (0.4%)	1 (0.2%)	2 (0.8%)	0.35
Pulmonary embolism	0 (0.0%)	4 (0.7%)	1 (0.4%)	0.39
Urinary tract infections	2 (0.7%)	0 (0.0%)	3 (1.2%)	0.04
Bladder neck contractures	3 (1.1%)	4 (0.7%)	0 (0.0%)	0.28
Postoperative ileus	0 (0.0%)	3 (0.5%)	1 (0.4%)	0.52
Pelvic fluid collections	0 (0.0%)	7 (1.2%)	0 (0.0%)	0.05
Total complications	9 (3.3%)	21 (3.5%)	7 (2.9%)	0.90
Follow up data				
Erectile function (SHIM \geq 16)*				
3 month	67 (69.8%)	154 (65.3%)	59 (62.1%)	0.53
6 month	102 (73.9%)	215 (74.9%)	92 (74.2%)	0.97
12 month	119 (85.6%)	266 (84.4%)	99 (82.5%)	0.77
Urinary continence (\leq 1 pad per day) [†]				
3 month	102 (73.9%)	274 (79.2%)	111 (77.6%)	0.45
6 month	151 (85.8%)	378 (90.4%)	141 (84.9%)	0.10
12 month	164 (91.6%)	400 (94.1%)	150 (91.5%)	0.38
PSA				
Median months To follow up (range)	12.4 (1.0-74.7)	12.3 (1.0-68.1)	12.5 (1.0-43.3)	
PSA \geq 0.2 ng/dL	7 (3.0%)	23 (4.3%)	15 (7.2%)	0.09

*SHIM scores were included only for patients who were preoperatively potent (SHIM \geq 16);

[†]Urinary continence was determined only for patients who were continent preoperatively.

more recent studies and those from Europe have demonstrated no difference in Gleason scores.^{11, 12, 16, 21-22, 42} The potential reasons for these different findings are outside of the scope of this manuscript, but could include the changing definitions of the Gleason score over time,²³ the difficulty performing digital rectal exam in the obese, selection bias, and the increasing prevalence of obesity in the past 15 years.

Several studies have investigated the impact of obesity on recurrence risk. Review of the SEARCH database revealed that following open prostatectomy, morbidly obese patients (BMI \geq 35) had a significantly higher risk of biochemical recurrence rates compared to obese men with a BMI between 30 and 35. However, the number of morbidly obese patients in this study was quite small, comprising less than 5% of the studied

population.⁸ Amling et al also reported that obesity is associated with increased recurrence risk.²⁴ However, both of these studies included patients diagnosed before the PSA era and its subsequent stage migration, suggesting that comparison of these data with our findings may not be appropriate. In contrast, there are two studies that report no relationship between biochemical recurrence and obesity.^{11, 25}

The biochemical recurrence risk in our study was similar in the three groups, yet there was a trend toward increased rates of recurrence with increased BMI (3.0% versus 7.2%, $p = 0.09$). As median biochemical follow up is short at just over 12 months, it is possible that this difference would achieve significance with longer follow up. Considering that the three groups had similar histopathologic features and rates of PSM, this

possible increased recurrence is likely explained by some aspect of tumor biology.

A possible explanation for the trend towards increased recurrence in obese patients is the typical upstaging that occurs at the time of surgery. In general, obese men have been noted to have worse pathologic outcomes on biopsy prior to surgery and are more likely to be upgraded and upstaged at the time of prostatectomy.²⁵⁻²⁷ Upstaging may be related to increased vascular volume and resultant serum hemodilution in the obese.²⁸⁻³⁰ That is, a given PSA output will be diluted in obese men relative to normal weight men due to their increased plasma volume, yielding a lower concentration. Obese patients would then be diagnosed later in the natural history of disease because PSA concentrations remain lower than comparable normal weight patients.

There has been some debate as to whether obesity predisposes patients to operative complications. It is clear that there are obese-specific anesthesia risks, namely difficulty maintaining adequate ventilation in the steep trendelenburg position required for RALP. The obese often require increased ventilatory pressures due to increased pressure on the thorax.^{24,31} Regarding postoperative complications, some studies have reported comparable outcomes in obese and normal weight patients in a variety of surgical settings.³²⁻³⁴ Other studies have found an association between obesity and poor surgical outcomes and perioperative morbidities.³⁵⁻³⁶ This has been demonstrated in the setting of open prostatectomy, where the incidence of perioperative morbidities in obese patients has been reported to be higher than in normal weight men. Van Roermund et al reported significantly higher risk of wound infections and bladder neck contractures in obese men undergoing open RRP.³⁷ An analysis of over 1000 open prostatectomies by Fitzsimons et al is remarkable for a trend between increasing BMI and increased EBL and operative time.³⁸ It should be noted, however, that not all open prostatectomy series have shown a relationship between increased BMI and perioperative complications.⁵

When evaluating RALP outcomes comparing obese to normal weight patients, differences in operating time and EBL have been consistently reported.¹⁰⁻¹¹

However, differences in EBL are small (50 mL) and likely not of clinical significance. Additionally, operating times differ by less than 30 minutes, and Wiltz et al reports a decline in operative time for RALP on obese patients with increasing surgical experience. Our results are consistent with these reports, although EBL differences were not significant in our cohort. While operative time differences were significant, the additional 6 minutes of surgery in obese compared to normal weight patients has minimal clinical relevance.

The urologic community has demonstrated that minimally invasive surgery may be superior to open surgery for retroperitoneal procedures in the obese.³⁹⁻⁴⁰ For prostate surgery, Tewari et al report that overall perioperative complications were eight times more likely in a group of patients after open prostatectomy compared to a RALP group (20 versus 2.5 complications per 100 patients). A similarly significant increase in complication rates for obese patients undergoing open versus laparoscopic prostatectomy was reported by Rassweiler et al.⁴¹ Our series demonstrated that UTIs were less common in overweight patients while pelvic fluid collections were more common. As there was no directional trend in these findings (i.e., it was only the middle, "overweight," group that displayed the differences, not the obese or normal weight groups), this likely represents statistical artifact rather than a true difference. Additionally, the overall rates of complications were similar. Therefore, our data suggest that RALP offers a minimally invasive technique that may offer similar surgical outcomes regardless of BMI.

Less frequently, there have been reports of quality of life impairments in obese men following prostatectomy. Ahlering et al described slower overall recovery and return of urinary control in 19 obese patients undergoing RALP.⁴² However, this study also reported lower baseline urodynamic and erectile function in obese and overweight patients as compared to normal weight men. We did not find such a difference, although our data excluded patients with baseline erectile dysfunction and provided only a qualitative assessment of urinary function.

Our study must be viewed in light of its limitations. Like many early reports of RALP outcomes, we have short follow up, making it too early to meaningfully analyze data pertaining to overall survival and long term biochemical recurrence. There is a discrepancy between the upper limit of the range of follow up (75 months) and the median follow up (12 months). This is partly due to the fact that we have higher volume now than at the beginning of the study period. It is also related to patients being lost to follow up. Most of our patients are referred from outside urologists, and tend to have their short term follow up with us before returning to their local urologist for long term follow up. We make every effort to follow the PSA of such patients, but inevitably, some are lost to follow up. The functional outcomes were monitored by the surgeon, which has been demonstrated to favorably influence the outcomes compared to patient reported outcomes.⁴³ Additionally, a retrospective, single surgeon series is not generalizable to the wider urologic community. Finally, the patients in this analysis were stratified by

BMI whereas some have suggested that other measures of adiposity, such as waist circumference or waist-to-hip ratio, may be more clinically relevant.⁴⁴⁻⁴⁵

Conclusions

Perioperative, functional, and histopathologic outcomes following RALP were similar among patients stratified by body mass index. This supports the continued utilization of RALP in obese and overweight men. As obese patients have been shown to have worse outcomes than normal weight men in open prostatectomy series, the lack of such difference in a robotic series suggests that this may be a better option for the obese patient desiring prostatectomy. However, longer follow up is necessary to address concerns regarding recurrence risk and postoperative quality of life. □

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