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Obesity Is Not Associated with Increased Operative Complications in Single-Site Robotic Partial Nephrectomy

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Purpose: To evaluate the impact of high body mass index (BMI) on outcomes following robotic laparoendoscopic single-site surgery (R-LESS) robotic-assisted laparoscopic partial nephrectomy (RPN). **Materials and Methods:** Data from 83 Korean patients who had undergone robotic partial nephrectomy from 2006 to 2014 were retrospectively analyzed. The subjects were stratified into two groups according to WHO definitions for the Asian population, consisting of 56 normal range (BMI=18.5–24.99 kg/m²) and 27 obese (≥25 kg/m²) patients. Outcome measurements included Trifecta achievement and the perioperative and postoperative comparison between high and normal BMI series. The measurements were estimated and analyzed with SPSS version 17. **Results:** Tumor's complexity characteristics (R.E.N.A.L. score, tumor size) of both groups were similar. No significant differences existed between the two groups with regard to operative time (p=0.27), warm ischemia time (p=0.35) estimated blood loss (p=0.42), transfusion rate (p=0.48) renal function following up for 1 year, positive margins (p=0.24) and postoperative complication rate (p=0.34). Trifecta was achieved in 5 (18.5%) obese and 19 (33.9%) normal weight patients, respectively (p=0.14). In multivariable analysis, only tumor size was significantly correlated with the possibility of Trifecta accomplishment. **Conclusion:** Our findings suggest that R-LESS RPN can be effectively and safely performed in patients with increased BMI, since Trifecta rate, and perioperative and postoperative outcomes are not significantly different in comparison to normal weight subjects.

Key Words: Body mass index, partial nephrectomy, robotic surgery

INTRODUCTION

The development of imaging techniques has increased the detection rates of smaller size and lower stage renal cell carcinomas (RCC).[1] Therefore, renal surgery is steadily evolving towards nephron-sparing minimally invasive procedures.[2] Robotic-assisted laparoscopic partial nephrectomy (RPN) is a minimally invasive technique associated with good functional and oncologic outcomes in the treatment of small and medium size renal masses.[3] RPN can be performed by either the multi-port (conventional) approach or by the laparoendoscopic single-site tech-

nique (R-LESS), with the latter being considered to achieve superior cosmetic outcome than multi-port technique.[4]

However, concerns remain regarding the safety and efficacy of RPN in patients with high body mass index (BMI). Obesity is one of the known risk factors for developing RCC, thus many patients who suffer from renal tumors and are treated with RPN are expected to have a high BMI.[5] Additionally, as the prevalence of obesity continues to rise, more obese patients are possible candidates of having minimally invasive procedures. Technical difficulties, secondary to body habitus and increased perirenal fat, may be encountered during surgery.[6] The correlation between BMI and perioperative and postoperative outcomes after RPN is controversial.[7-9]

In order to determine the influence of high BMI on the outcomes of patients who have undergone R-LESS partial nephrectomy (PN), we performed a retrospective analysis of our R-LESS RPN series, focusing on the impact of high BMI in regard to perioperative and postoperative outcomes, and Trifecta accomplishment. To our knowledge, no study has so far been carried out regarding the influence of BMI on the operative outcomes of R-LESS PN, as well as the effect of high BMI in terms of Trifecta achievement.

MATERIALS AND METHODS

Patient's selection and outcome measurements

Data of 220 Korean patients with renal tumor, who had undergone multi-port and LESS robotic partial nephrectomy by a single surgeon in a tertiary institute, between October 2006 and March 2014, was obtained and retrospectively analyzed from our prospectively maintained Institutional Review Board approved database. One hundred-seventeen patients who underwent conventional (multi-port) RPN were excluded from the analysis.

BMI was defined as the weight in kilograms divided by the square of the height in meters. The subjects were categorized into two groups according to WHO definitions for the Asian population, consisting of 56 normal range (BMI= 18.5–24.99 kg/m^2) and 27 high BMI (≥25 kg/m^2) patients who underwent R-LESS PN.[10] The patients were sequentially enrolled to either conventional RPN or R-LESS PN without any selection criteria.

Outcome measurements were Trifecta achievement, as well as the perioperative and postoperative outcomes. Based on our previous published article regarding Trifecta accomplishment, we defined Trifecta achievement as a combina-

tion of warm ischemia time (WIT) less than 20 minutes, negative surgical margins and no surgical complications as a denotation of oncological and surgical safety, respectively.[11] Postoperative complications were recorded for a duration of three months after surgery, according to Clavien-Dindo classification system.[12]

Preoperative clinical and demographic characteristics [age, gender, BMI, tumor size, physical status classification of American Society of Anesthesiologists (ASA), estimated glomerular filtration rate (eGFR), R.E.N.A.L. score] were retrospectively analyzed in order to identify possible significant differences between the baseline characteristics of these groups. R.E.N.A.L. scoring system was used to account for tumor complexity.[13] Perioperative and postoperative outcomes and surgical complications were also analyzed and compared between the groups [operative time, estimated blood loss (EBL), WIT, postoperative eGFR, number of patients with positive surgical margins, days of hospitalization –length of stay, days of drain maintenance, number of patients who underwent conversion to radical nephrectomy surgery]. In order to estimate the impact of high BMI on the functional outcome, we counted and compared the eGFR, in addition to eGFR percentage change, between the groups. eGFR percentage change was defined as the percentage of difference between preoperative and postoperative eGFR in each group (eGFR change: 1-postoperative eGFR/preoperative eGFR×%). Patient's e-GFR was determined using the Modification of Diet in Renal Disease Formula.[14] The postoperative renal function was evaluated in a intermediate term follow up of one year.

Surgical technique

The R-LESS PN procedure was performed according to our previously described approach.[15] A homemade single-port device was used in all cases. Laparoscopic ultrasound was used intraoperatively in all cases, in order to identify tumor depth and margin. The surgical steps included tumor identification, temporary occlusion of the renal vessels, tumor excision and renorrhaphy using the sliding clip technique.

Statistical analysis

Differences between the two groups were compared by using either the Mann-Whitney test for continuous variables or the chi-square test for 2×2 contingency or larger tables, respectively. Counts of frequencies were expressed as percentages and continuous data were presented as the median and interquartile range. A multivariate binary logistic regression anal-

ysis was also performed, so as to determine the most important explanatory variables for Trifecta accomplishment.

For all statistical analyses, a two-sided *p* value <0.05 was considered statistically significant. All analyses were performed using SPSS version 17 statistical package (SPSS Inc., Chicago, IL, USA).

RESULTS

There were no statistically significant differences in the baseline characteristics between the two groups regarding age (*p*=0.88), ASA score (*p*=0.24), tumor size (*p*=0.62), tumor side (*p*=0.77), R.E.N.A.L. score (*p*=0.84) and T stage (*p*=0.62) of the tumor. Despite the fact that increased percentage of malignant tumors was observed in high BMI subjects, this was not statistical significant (*p*=0.20). The patients' clinical and demographic characteristics are summarized in Table 1.

Table 2 presents the perioperative and postoperative data of both groups. With regard to perioperative outcomes, we did not detect any statistical significant differences between the two groups regarding operative time, WIT, EBL, rates of patients with positive surgical margins (2.2% vs. 8.0% for normal and high BMI patients, respectively), surgical complications, days of hospitalization and drain preservation (*p*=0.25, 0.35, 0.42, 0.24, 0.34, 0.80, 0.62, respectively). We did not also find any statistically significant differ-

ences between the groups regarding to postoperative renal function, as estimated by the measurement of eGFR and the eGFR percentage change at postoperative day 1, 1 week, 1 month, 3 months, 6 months, and 1 year after surgery (*p*=0.87 and 0.53, 0.78 and 0.98, 0.72 and 0.45, 0.61 and 0.42, 0.80 and 0.97, 0.84 and 0.29, respectively) (Fig. 1). In two patients with normal BMI, a conversion to radical nephrectomy was performed, due to severe perioperative hemorrhage or difficulties in assessing the tumor extension with the robotic arms (*p*=0.32). Three patients with high BMI required endoscopically ureteral stent placement due to urinary leakage (2 patients) and renal artery embolization due to hemorrhage (1 patient). Seven patients (12.5%) in normal BMI group and two (7.4%) in high BMI group required blood transfusion (*p*=0.48). Trifecta was achieved in 19 normal weight patients (33.9%) and 5 patients (18.5%) of high BMI group (*p*=0.14).

Multiple logistic regression analysis, detected that tumor size was the only variable which could predict the failure of achieving Trifecta (odds ratio: 1.964, *p*=0.013) (Table 3).

DISCUSSION

With the rising incidence of obesity worldwide and the increasing use of robot in the treatment of renal tumors, numerous overweight patients are expected to undergo RPN.

Table 1. Clinical and Demographic Characteristics of Patients*

Characteristic	Normal BMI (18–25 kg/m^2)	High BMI (>25 kg/m^2)	*p* value
Number	56	27	
Sex (n)	F (23)/M (33)	F (8)/M (19)	0.31
Age (yrs)	52.5 (44–61)	51 (44–61)	0.88
BMI (kg/m^2)	22.5 (21.1–23.7)	27.0 (25.3–28.3)	<0.001
Side (n)	L (23)/R (33)	L (12)/R (15)	0.77
ASA score (%)			0.24
1	80.0	74.1	
2	14.5	25.9	
3	5.5	0.0	
Tumor size (cm)	2.7 (1.75–4.0)	3.0 (2.0–4.7)	0.62
R.E.N.A.L. score	7 (6–9)	7 (6–9)	0.84
Malignancy (%)	82.1	92.6	0.20
pT stage (%)			0.62
T1a	78.3	68.0	
T1b	19.6	28.0	
T2	2.2	4.0	
T3	0.0	0.0	

n, number; F, female; M, male; BMI, body mass index; L, left; R, right; ASA, physical status classification of American Society of Anesthesiologists.
*Continuous variables are expressed as median and interquartile range.

Table 2. Perioperative and Postoperative Outcomes of Both Groups*

Variable	Normal BMI (m±SD)	High BMI (m±SD)	p value
Operative time (min)	190 (148–220)	203 (176–247)	0.27
WIT (min)	25 (16–31)	27 (21–36)	0.35
EBL (mL)	200 (50–500)	300 (50–500)	0.42
BT (n, %)	7 (12.5)	2 (7.4)	0.48
PSM (%)	1 (2.2)	2 (8.0)	0.24
Clavien III–IV complications (%)[†]	1 (3.6)	3 (11.1)	0.34
Conversion to RN (n, %)	2 (3.6)	0 (0.0)	0.32
Drain (d)	2.0 (2–3)	2.5 (2–3)	0.62
LOS (d)	4.0 (3–5)	4.0 (3–5)	0.80
Trifecta (n) (%)	19 (33.9)	5 (18.5)	0.14
Preop. eGFR	85.1 (78.1–94.0)	85.4 (75.1–94.2)	0.91
1st day eGFR	66.0 (58.7–78.6)	67.4 (51.1–84.4)	0.87
1st day eGFR change (%)	-22.5 (-29 to -7)	-21.8 (-39 to -7)	0.53
1st yr eGFR	81.0 (67.3–95.3)	78.2 (69.2–90.9)	0.84
1st yr eGFR change (%)	-2.7 (-17 to -7)	-8.2 (-17 to -7)	0.29
Follow-up (months)	47 (40–52)	47 (37–51)	0.42

BMI, body mass index; EBL, estimated blood loss; BT, patients that required blood transfusion; WIT, warm ischemia time; PSM, positive surgical margins; RN, radical nephrectomy; LOS, length of stay; eGFR, estimated glomerular filtration rate (mL/min/1.73 m^2); eGFR change (%), 1-(postoperative eGFR/preoperative eGFR)×%.
*Continuous variables are expressed as median and interquartile range.
[†]Three patients with high BMI required endoscopically ureteral stent placement due to urinary leakage (2) and renal artery embolization due to hemorrhage (1).

Additionally, the acceptance of R-LESS technique as a procedure with better cosmetic outcome and less postoperative pain than the conventional approach will probably result in an increased appliance of R-LESS PN in overweight patients.[4] Therefore, studies regarding the safety and efficacy of R-LESS RPN in individuals with high BMI are required.

According to many authors including us, Trifecta achievement (i.e., the triple goals of negative surgical margins, functional preservation and complication free recovery) following robotic partial nephrectomy remains the surgeon's top priority in the treatment of a patient having a malignant tumor.[16-18] In the present study, therefore, we analyzed our data with regard to Trifecta accomplishment. To our best knowledge, the current analysis represents the first analysis comparing Trifecta achievement in obese versus normal BMI patients in R-LESS RPN procedure.

The present study demonstrates that R-LESS PN is efficient and safe in subjects with high BMI, since no significant difference was detected regarding complication rate, transfusion rate, operative time, WIT, functional outcome and oncological safety compared to normal BMI patients. Moreover, the Trifecta rate was similar in both groups, suggesting that RPN can be safely performed in patients with increased BMI.

Although the rates of Trifecta accomplishment were similar between patients with high and normal BMI, we ob-
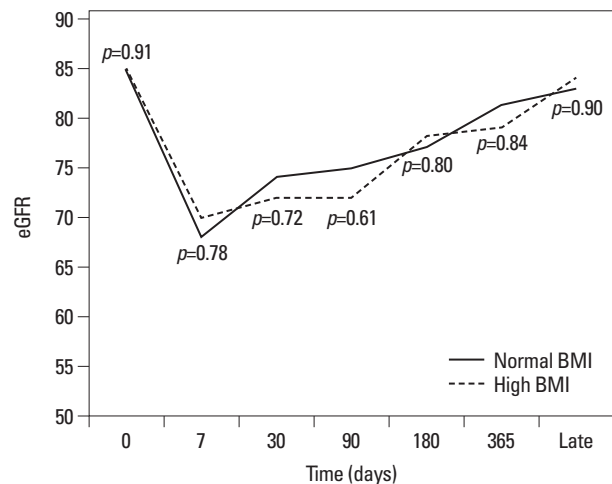

Fig. 1. eGFR (mL/min/1.73 m^2) trends during a period of 12 months after R-LESS PN in patients with normal BMI and high BMI, respectively. eGFR, estimated glomerular filtration rate (mL/min/1.73 m^2); BMI, body mass index; R-LESS, robotic laparoendoscopic single-site surgery; PN, partial nephrectomy.

served lower Trifecta rates in the R-LESS PN group than previously published studies.[19] This could probably be explained by the stringent definition of Trifecta that we have used in our analysis (WIT <20 min, no complications, negative margins). Moreover, in a previous study from our group, Trifecta achievement rates were found to be lower in the R-LESS PN group compared to the conventional approach.[11]

Analyzing our data, we detected that obese patients were more likely to be males and having malignant tumors, al-

Table 3. Binary Logistic Regression Analysis of Trifecta Accomplishment

Variable	OR	95% CI	*p* value
High BMI	3.138	0.82–11.8	0.093
Age	1.009	0.96–1.06	0.737
Operative time	1.005	0.99–1.01	0.165
Tumor size	1.964	1.15–3.34	0.013
R.E.N.A.L. score	1.293	0.89–1.87	0.178

OR, odds ratio; CI, confidence interval; BMI, body mass index.

though this was not statistically significant. This is logical since there is an evidence to suggest obesity as a risk factor for renal cell carcinoma (RCC), due to the production of inflammatory factors in adipose tissue (adipokines) and the increased concentration of free estrogens, insulin-like growth factor-I and lipid peroxidation.[20,21]

Since the perioperative and postoperative comparison could be influenced by the different anatomic and topographic characteristics of the treated tumor, we also estimated and compared tumor complexity in both groups by R.E.N.A.L. score.[13] R.E.N.A.L. score and tumor size were not significantly different between high BMI and normal weight patients. Therefore, we believe that a tumor's complexity does not constitute a confusing factor in our results, while surgical confounders were minimized using the outcomes of a single surgeon.

Our results are in agreement with the study of Isac, et al.[7] The authors analyzed the data of 250 patients who had undergone conventional RPN and also found not significant difference between the groups in terms of operation duration, WIT, transfusion rate and postoperative complication rate. They also reported significant difference in EBL only in patients with highly increased BMI (>40), whereas similar transfusion rate between the groups. In the present study, blood loss volume was higher in overweight patients, however, this was not statistically significant. Moreover, the transfusion rate was comparable between the high and normal BMI patients (7.4% and 12.5%, respectively).

Naeem, et al.,[8] in their study of 97 patients, found that the obese patients had a higher EBL and a trend toward longer operative time and WIT, which did not achieve statistical significance. In our series, we also observed that WIT was greater in high BMI group (25 minutes vs. 27 minutes), but the difference was not statistically significant.

In contrast, Kiziloz, et al.[9] found that increasing BMI is significantly associated with longer operative time, length of hospital stay and increased EBL, whereas there are no correlations between BMI, WIT, change in eGFR, and perioperative and postoperative complications. Nevertheless,

the authors concluded that RPN can be safely performed in high-volume centers.

Recently, Aboumarzouk, et al.[22] meta-analyzed the published data of laparoscopic partial nephrectomy in obese patients and observed comparable outcomes between obese and non-obese patients, despite the fact that laparoscopic partial nephrectomy constitutes a more challenging procedure.

In all of the above studies, the renal function evaluated by eGFR was not influenced by the increased BMI. This is also supported by our analysis, in which we did not detect any significant difference in the postoperative renal function of the groups, although eGFR and eGFR percentage changes were measured in a medium term follow up of 12 months.

There are three limitations in our study. First, this study is a retrospective nature, although data were retrieved from a prospectively maintained institutional database. Second, all the procedures were performed by a very experienced robotic surgeon specialized in minimally invasive PN procedures, who had reached the learning curve for both techniques. Therefore, the current findings might not apply to other populations in different hospital settings. Third, the classification of obesity in Asians is different compared to the European and American population, therefore, the findings of our study might not be similar in other regions. However, the findings in the current literature concur with most of those in the present study.

In conclusion, we do not necessarily advocate robotic assistance for all obese patients undergoing partial nephrectomy, nevertheless, our findings suggest that R-LESS partial nephrectomy can be effectively and safely performed to overweight patients, since major parameters, such as post surgery renal function (eGFR), surgical complications and oncological safety are not significantly different in comparison to normal weight individuals.

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