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Original Article

Impact of warm ischemia time on the change of split renal function after minimally invasive partial nephrectomy in Taiwanese patients

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Abstract

Background: Nephron-sparing surgery has become the standard treatment for T1 renal tumors. However, relevant data on the Taiwanese population are lacking, and most of the current literature uses global instead of split renal function (SRF) for postoperative renal function follow-up. We evaluated the postoperative renal function after minimally invasive partial nephrectomy in Taiwanese patients.
Methods: We retrospectively reviewed our database from April 2004 to July 2012 and enrolled patients who received laparoscopic partial nephrectomy (LPN) or robot-assisted partial nephrectomy (RPN). The estimated glomerular filtration rate (eGFR) and SRF were calculated as representatives of renal function. The preoperative and 6- and 12-month postoperative renal functions were assessed. Freidman test was used to evaluate pre- and postoperative renal function changes; Wilcoxon test was used for comparing the renal function of each period.
Results: The 6- and 12-month postoperative SRF values were decreased compared with the preoperative values. Multivariate analysis revealed that older age was related to a lower postoperative eGFR, and a longer warm ischemia time was related to a decreased postoperative SRF. Patients with a warm ischemia time of >30 minutes were correlated with a larger mean tumor size, higher "preoperative aspects and dimensions used for an anatomical" score, greater amount of blood loss during the operation, longer postoperative hospital stay, and lower postoperative SRF compared with patients with a warm ischemia time of <30 minutes. Patients in the RPN group had shorter warm ischemia time and higher 6-month postoperative SRF compared with patients in the LPN group.
Conclusion: SRF is more sensitive for postoperative follow-up than eGFR. Longer warm ischemia time is associated with poorer postoperative renal function. RPN is a safe and feasible alternative to LPN.

Keywords: laparoscopy; nephrectomy; robotics; warm ischemia

1. Introduction

Nephron-sparing surgery has gained popularity in the treatment of T1 renal tumors.[1] It provides a similar cancer control outcome to radical nephrectomy with the benefit of renal function preservation.[2] The introduction of minimally invasive surgery has also become more acceptable because of improved cosmetic results and less pain after the operation; however, the steep learning curve and the difficulty of intracorporeal suturing have limited the widespread use of laparoscopic partial nephrectomy (LPN).[3] The emergence of robot-assisted partial nephrectomy (RPN) has shown promising results and involves a shorter learning curve and decreased warm ischemia time (WIT), total operation time, and estimated blood loss (EBL) in some studies.[1,4] The optimal length of WIT is debatable, with some investigators reporting that a cutoff of 20 minutes, 30 minutes, or 40

Conflicts of interest: The authors declare that there are no conflicts of interest related to the subject matter or materials discussed in this article.

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minutes or longer causes a decline in renal function.[5–7] Patel and Eggener[8] coined the phrase "every minute matters" to stress the negative effect of longer WIT on renal function. We present the largest series of minimally invasive partial nephrectomy data in Taiwan and share our experience of postoperative outcomes in terms of overall, LPN, and RPN results.

2. Methods

From April 2004 to July 2012, a total of 94 patients received LPN and 75 patients underwent RPN in our institute. We obtained verbal informed consent from all patients and followed the provisions of the Declaration of Helsinki. Most (>90%) of the operations were performed by one surgeon. Patients with missing data, solitary kidney, intraoperative conversion to open nephrectomy, or bilateral renal surgery were excluded from this study. The estimated glomerular filtration rate (eGFR) and split renal function (SRF) were used as representatives of postoperative renal functions. The eGFR was calculated using the Modification of Diet in Renal Disease equation:

$$\text{eGFR} = 186 \times (\text{serum creatinine})^{-1.154} \times (\text{age})^{-0.203} \times 0.742(\text{in females}). \quad (1)$$

The SRF was calculated as the percentage of effective renal plasma flow (ERPF) of the diseased kidney divided by the total ERPF. ERPF is a nuclear medicine test. I-131-orthoiodohippurate (300 μCi) was injected for the test. The patient was instructed to lay supine on the examination table of the machine; then, the activity of the injected agent over the bilateral renal area was recorded for 27 minutes, and the emissions of both sides were counted and calculated. The emission over the bladder was also recorded for 1 hour for pre- and postvoiding activity. The total and each side's emission activity were then reported. The renal functions were monitored at three different time points: preoperatively, 6 months postoperatively, and 12 months postoperatively. We evaluated the correlation of renal function with age, body mass index, EBL, higher "preoperative aspects and dimensions used for an anatomical" (PADUA) score,[9] and preoperative tumor size on a computed tomography scan with the aforementioned time points. Frozen sections were not routinely sent for pathological evaluation during the surgery; this was only done if the surgeon suspected that the surgical margin was not free of tumor.

In the second part of our study, the patients who had received minimally invasive partial nephrectomy were divided into two groups: WIT ≤30 minutes and WIT >30 minutes. Change in renal function was evaluated at the previously mentioned time points. In the third part of the study, we divided minimally invasive partial nephrectomy patients into RPN and LPN groups and evaluated the correlation of postoperative renal function between the two groups.

Means and standard deviations were used for reporting continuous variables. The Mann–Whitney test was used to compare continuous variables, and Chi-square test was used for comparing categorical variables, which were used to compare the perioperative parameters between the WIT ≤30 minutes and WIT>30 minutes groups and also between the LPN and RPN groups. The Freidman test was used to evaluate the significance of change of renal functions 6 months and 12 months postoperatively compared with preoperative values, and the Wilcoxon test—modified using the Bonferroni correction method—was used for comparing the renal functions of each period. All tests were two-sided, and $p < 0.05$ was considered statistically significant, except with the Bonferroni correction method ($p < 0.0167$ revealed significance). All statistical analyses were performed using PASW Statistics version 18.0 (SPSS Inc., Chicago, IL, USA).

3. Results

There were 169 patients enrolled in the study. Two of those received surgery on both kidneys, and three underwent intraoperative conversion to radical nephrectomy owing to the intraoperative surgical margin frozen section being positive for malignant cells. There were 52 patients with incomplete preoperative and follow-up data, which left 102 patients in our study. Of the 102 patients, 64% were men and 46% received RPN. The mean overall age was 57.1 ± 13.7 years, the mean American Society of Anesthesiologists score was 2.03 ± 0.63, and the mean tumor size was 3.75 ± 1.81 cm. The mean overall operative time was 256.9 ± 79.7 minutes, the mean WIT was 35.4 ± 21.7 minutes, and the mean EBL was 403.4 ± 607.3 mL. The median PADUA score was 8.1 ± 1.6 points, the percentage of malignant lesions was 56.9%, and the mean postoperative hospital stay was 6.0 ± 2.7 days (Table 1). The 6-month postoperative eGFR (81.43 ± 26.3) was decreased compared with the preoperative values (87.95 ± 24.46, $p < 0.001$), but the 12-month postoperative eGFR (82.28 ± 25.04) did not reach statistical significance when comparing with preoperative and 6-month postoperative values ($p = 0.074$ and $p = 0.215$, respectively; Table 2). Both the 6- and 12-month postoperative SRF (0.42 ± 0.13 and 0.44 ± 0.07, respectively) showed a significant decrease

Table 1
Patient characteristics.

Age (y)	57.1 ± 13.7
Sex: male/female (%)	65/37 (64/36)
No. of patients: RPN/LPN (%)	47/55 (46/54)
ASA score	2.03 ± 0.63
Mean tumor size (cm)	3.75 ± 1.81
Operative time (min)	256.9 ± 79.7
WIT (min)	35.4 ± 21.7
EBL (mL)	403.4 ± 607.3
PADUA score	8.1 ± 1.6
No. of malignant lesions (%)	68 (56.9)
Postoperative hospital stay (d)	6 ± 2.7

ASA = American Society of Anesthesiologists; EBL = estimated blood loss; LPN = laparoscopic partial nephrectomy; PADUA score = preoperative aspects and dimensions used for an anatomical classification score; RPN = robot-assisted partial nephrectomy; WIT = warm ischemia time.