Open Partial Nephrectomy without Ischemia

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Abstract

Background: Vascular clamping during partial nephrectomy could induce to renal ischemia and kidney's damage due to reperfusion injuries. Adverse effect on renal function can be eliminated by Zero ischemia techniques. The aim of this study was to assess the feasibility of performing partial nephrectomy under a situation of being ready to clamping renal artery. **Methods:** 24 patients with solitary small renal masses were recruited to the study between 2013 and 2018. Open partial nephrectomy was performed for them. During the time corresponding to hilar vessels clamping in standard procedures, we have reached to the renal artery and ready for clamping if needed, and in this situation resection of the mass was assessed. **Results** The mean age of patients was 42 years. The tumor resection time was 22 minutes averagely. The median procedure time was 92 minutes, Clear cell RCC was found in 19 patients, papillary RCC in 3 and oncocytoma in 2 with no positive surgical cancerous margin in specimens. Lower pole, midzone and upper pole masses were found consequently in 14, 2 and 8 cases. **Conclusions:** Although this technique could be a dangerous decision making in a well exposed renal artery, especially in Polar Regions, the tumor resection can be safely conducted without ischemia.

Background

Although renal masses can be malignant, benign, or inflammatory, the most common malignant renal mass is renal cell carcinoma (RCC), accounting for 2-3% of all kinds of adults' cancers. Historically the gold standard treatment for RCC was radical nephrectomy (RN), but recent studies suggested that partial nephrectomy (PN); in compared to radical nephrectomy (RN), may be associated with improved survival for small renal tumors (between 4 centimeters (cm) or less and 7 cm or less), and has the benefit of preserving renal function (1). Although RN is a known risk factor of chronic kidney disease (CKD) in patients with renal tumors, it is still the most common procedure which is performed in patients with small renal tumors (2). PN mostly used for patients who would be rendered anephric after radical nephrectomy, for example patients with bilateral RCC and single kidney patients with RCC were subjects of PN and the fear of positive surgical margins leading to increase the risk of local recurrence, limited the widespread use of PN. The significant improvement in imaging techniques has led to increased detection of small renal tumors and caused PN to be used for this small renal tumors (3). Application of Vascular clamp during PN can lead to renal ischemia and the consequences that are called reperfusion injuries. Adverse impact on renal function (RF) can be eliminated by Zero

ischemia techniques. We plan to assess the possibility of performing PN under a situation of being ready to clamping renal artery.

Methods

During a retrospective study, 24 patients with solitary small renal masses were recruited to the study between 2013 and 2018. Open partial nephrectomy was performed for them. During the time corresponding to hilar vessels clamping in standard procedures, we have reached to the renal artery and ready for clamping if needed, and in this situation resection of the mass was assessed. All patients underwent the procedure with 1 to 2 centimeters of free margins. All of the patients were evaluated by abdominal spiral CT Scan without and with intravenous Contrast for defining the exact size and location of the renal masses.

Results

The mean (SD) age of patients was 41.96 (4.94) years. The tumor resection time was 22.08 (2.50) minutes averagely (with range 18-28 minutes). The mean procedure time was 92 ($\pm$ 4.6) minutes (range 72-128 minutes), estimated blood loss was 300($\pm$ 62) ml (range 200-500 ml) with no case of transfusion and the mean diameter of tumors was 31.92 (4.39) mm (range 22-39 mm). Clear cell RCC was found in 19 patients, papillary RCC in 3 and oncocytoma in 2 with no positive surgical cancerous margin in specimens (table 1). Lower pole, midzone and upper pole masses were found consequently in 14, 2 and 8 cases (table 2). The level of serum Cr remained normal when measured daily until the day of discharge (median 5 days, range 4 -7 days). The demographic characteristics of the patients and the tumors were shown in table 1.

Table 1: frequency distribution of demographical and type of tumor of patient under study

Variable Name	Variable Level	Frequency	Percent
Sex	Female	8	33.30
	Male	16	66.70
	Total	24	100.00
Side	Right	11	45.80
	Left	13	54.20
	Total	24	100.00
Tumor site	Lower pole	14	58.30
	Mid zone	2	8.30
	Upper pole	8	33.30
	Total	24	100.00
Complications	No complication	13	54.20
	Fever	5	20.80
	Knee pain	2	8.30
	Fever + pain	4	16.70
	Total	24	100.00
Pathologic type of tumors	Clear cell RCC	19	79.17
	Papillary RCC	3	12.50
	Oncocytoma	2	8.33

Table 2: mean and standard deviation distribution of continuous variables in patients under study

Variable name (measure unit)	N	Min-Max	Mean (SD)
Age (year)	24	37-57	41.96 (4.94)
Tumor size(mm)	24	22-39	31.92 (4.39)
Procedure time(min)	24	18-28	22.08 (2.50)
Length of stay in hospital (day)	24	2-7	5.00 (1.35)

Discussion

Today PN is an accepted procedure for small renal malignant tumors, but there are many options for performing this procedure according to preference of the surgeon, situation of the patient, and availability of surgical equipment, ablative procedures, open, laparoscopic, and robotic surgery may be selected. At the present time for managing renal tumors it is emphasizes to conduct a nephron sparing technique due to similar oncogenic results while

potentially reducing renal and cardiovascular morbidity in comparison to RN (4). While open RN has been the gold standard procedure for renal tumor operation, PN is currently utilized for renal tumor surgery in both high and low volume urological centers worldwide. Many previous studies has revealed better overall survival in patients who undergo PN compared to RN, and has shown at least similar oncological outcomes (5).

Although at the present time PN is the gold standard treatment for localized and small renal tumors, however, there is no consent over the effects of duration and type of intraoperative ischemia on renal function after PN (6). For evaluating the renal function after PN or RN, serum Cr is measured, although this test is not a reliable indicator of renal function, it is currently the most commonly used, and the easiest test for assessing renal function after partial nephrectomy. The pathogenesis of acute ischemia on renal function that causes acute kidney damage is based on vascular events, obstructive events, and reperfusion injuries. During these three inevitable processes persistent vasoconstriction and abnormal response of endothelial cells, formation of casts by sloughed tubular epithelial cells in the kidney and membrane debris that obstruct tubules, and finally generation of reactive oxygen species, hyper coagulation states, cellular derangement, and micro vessel congestion and compression can significantly reduce renal blood flow. On the other hand, there are many preoperative factors that can have influence on postoperative renal function. Age, sex, tumor size, presence of solitary functional kidney, ischemia type, duration of ischemia, amount of preserved functional kidney, and kind of surgical intervention are among these effective factors. The optimum time of ischemia during PN has not been determined yet, but warm ischemia time (WIT) less than 30 minutes historically thought to allow complete recovery of kidney function. In spite of this data, in a human study in 40 patients who underwent open partial nephrectomy with WIT more than 30 minutes, a greater than expected resistance to ischemia time was shown (7). Overall, according to several studies, 20 to 25 minutes represents the most accurate cut- off to separate patients who do and do not develop short and long term renal function decline after PN (8-14).

In a clinical trial by Rezaeetalab and coworkers for comparing laparoscopic (LPN) versus open partial nephrectomy (OPN), for small renal tumors, they have shown that LPN has some benefits over OPN, including decreasing post-operative pain and higher patient satisfaction, but have suggested higher possibility of positive tumor margin and urinary leakage in LPN (15). This study correlates with our study in the point of no complication.

In a meta-analysis by Leow JJ and coworkers for comparing outcomes of robotic partial nephrectomy (RPN) versus LPN, demonstrated that RPL confers a superior morbidity profile compared to LPN in most of the studies (16). We didn't have any significant morbidity in our study.

In 2 consecutive systematic reviews and meta-analyses by Zhonghua Shen and coworkers and Xia L. and coworkers for comparing perioperative outcomes of robot-assisted partial nephrectomy (RAPN) and OPN, demonstrated that RAPN offered a reduced perioperative complications, lesser blood loss, and shorter period of hospital admission than OPN, suggesting that RAPN may be an useful alternative to OPN(17, 18). We didn't have availability to robotic surgery and regarding the cost of robotic surgery it may have a negative point in our center.

In another systematic review by Wang Y. and coworkers for evaluating the cost-effectiveness of management options for small renal mass surgeries, ablation was cost-effective versus nephron sparing surgery and LPN was cost-effective versus the open approach (19). In our study OPN is a significant cost-effective procedure with no need for expensive equipment.

Morelli L. and coworkers in a clinical trial using Robotic surgery and hemostatic agents in partial nephrectomy lead to higher rate of success (82%) without vascular clamping and suggested RAPN as a technique to overcome technical challenges of LPN (20). We didn't have any technical challenge in our clinical trial.

Nowadays open PN is evolving as the standard of care for management of all amendable renal tumors with laparoscopic and robotic assisted surgery has being widely used(21).

Regarding better preservation of renal function in OPN, in comparison to RN, this technique seems to have a major benefit. LPN seems to be associated with a longer ischemia time, a higher re-operative rate, and also increased complication rates. Currently, surgeons have main concerns over preservation of renal function in any operative techniques with continued efforts toward decreasing warm ischemia without compromising the oncological efficacy (21). In our study we have omitted any type of ischemia in setting of exposed renal artery, ready for clamping and this means lower risk of ischemia in preserved, functioning and healthy renal tissue.

Funahashi Y. and coworkers compared warm and cold ischemia on renal function after PN and reported that warm ischemia for more than 25 minutes caused widespread injuries to the operated kidney, whereas cold ischemia for less than 58 minutes prevented ischemic injury to the preserved part of the kidney (22). We didn't use any type of ischemia, as a result, no ischemia induced complication could be considered.

In a study conducted by Jiwei Huang and coworkers found that in comparison to conventional LPN, by considering the safety and efficacy of laparoscopic radio frequency ablation (LRFA) during a prospective randomized controlled trial, LRFA assisted tumor enucleation with no ischemia, enables tumor excision with better renal function preservation (23). This clinical trial confirms the feasibility and safety of our study.

Partial nephrectomy is an accepted procedure for small renal malignant tumors both in high and low volume centers. There are many options for performing this procedure according to preference of the surgeon, situation of the patient, and availability of surgical equipment. In our technique of surgery, we have omitted any type of ischemia in setting of exposed renal artery and showed that this technique may be feasible and cost effective. We suggest more studies with higher number of patients to support the results of this study.

Conclusions

Partial nephrectomy is an accepted procedure for small renal malignant tumors, but there are many options for performing this procedure according to preference of the surgeon, situation of the patient, and availability of surgical equipment, ablative procedures, open, laparoscopic, and robotic surgery may be selected. Current management of renal tumors focuses on nephron sparing techniques due to equivalent oncogenic results while potentially decreasing renal and cardiovascular morbidity compared to radical nephrectomy. Every type of ischemia may have the potential of developing short- and long-term renal function decline after partial nephrectomy, but in our technique of surgery we have omitted any type of ischemia in setting of exposed renal artery, ready for clamping and this means lower risk of ischemia in preserved, functioning and healthy renal tissue. On the other hand, in our study OPN is a significant cost-effective procedure with no need for expensive equipment.

Declarations

Competing interests

The authors declare no competing interests.

Compliance with Ethical Standards (Ethical approval and Consent to participants):

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This confirmation was done by Yasuj University of Medical Sciences Research Committee. All participants have a written consent paper that is saved in their Medical Records.

Author Contributions Statement

All authors listed have contributed sufficiently to the project to be included as authors, and all named authors have seen and approved the final version of the manuscript.

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Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request. All data about the participants are gathered in a table, and are available on request.

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Abbreviation

RCC = Renal Cell Carcinoma

OPN = Open Partial Nephrectomy

RN = Radical Nephrectomy

PN = Partial Nephrectomy

CKD = Chronic Kidney Disease

RPN = Robotic Partial Nephrectomy

RAPN = Robotic-Assisted Partial Nephrectomy

LPN = Laparoscopic Partial Nephrectomy

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