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Retroperitoneal laparoscopic partial nephrectomy with selective renal artery clamping for renal cell carcinoma: initial outcomes

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Introduction: To explore the feasibility and safety of retroperitoneal laparoscopic partial nephrectomy (RLPN) with selective artery clamp (SAC) in patients with renal cell carcinoma (RCC).

Methods: The authors recruited three men and two women who underwent RLPN for T1 RCC between December 2022 and May 2023 at a tertiary hospital. The median age of the patients was 32 years (range, 25–70 years). The tumour size ranged from 3 to 4.5 cm. The R.E.N.A.L scores were 4x, 5p, 8a, 5a, and 8ah. The median preoperative eGFR was 96.9 (74.3–105.2). Renal computed tomography angiography was performed before the surgery to evaluate the artery branches. The operation time, number of clamped arteries, warm ischaemic time (WIT), intraoperative blood loss, RCC type, postoperative hospital stay, changes in renal function, and complications were evaluated. The follow-up duration was 6 months.

Results: The median operation time was 120 (75–150) minutes. One artery was clamped in four patients, while three were clamped in one patient. The median WIT was 22 (15–30) min, and the median blood loss was 150 (100–300) ml. No complications were recorded, and the resection margin was negative in all patients. The median decrease in eGFR was 6 (4–30%).

Conclusions: RLPN with SAC for T1 RCC is safe and feasible in clinical practice.

Keywords: kidney neoplasms, retroperitoneal laparoscopic partial nephrectomy, selective renal artery clamping

Introduction

Renal cell carcinoma (RCC) is the most prevalent neoplasm of the kidney, accounting for ~2.4% of all cancer diagnoses[1]. The worldwide mortality rate for RCC is estimated 4.6 per 100 000 in men and 1.8 per 100 000 in 2020[1]. Partial nephrectomy (PN) has become the gold standard treatment for T1 renal cell carcinoma[2]. One of the major challenges of PN is ensuring that warm ischaemia time (WIT) is not too long, as this factor affects postoperative renal function[3]. To overcome this challenge, many techniques have been studied, including selective renal artery clamping (SAC)[4].

HIGHLIGHTS

- Selective artery clamp (SAC) is expected to shorten warm ischaemic time in partial nephrectomy (PN) for renal cell carcinoma (RCC), preserving kidney function.
- SAC in retroperitoneal PN could be an alternative option for patients with T1 RCC.
- SAC in retroperitoneal PN for RCC is safe and feasible.

SAC during PN is not a novel technique. However, most studies on this topic have utilized robot-assisted surgery or transperitoneal laparoscopic surgery[5,6]. At our institution, we have experienced surgeons who are familiar with retroperitoneal PN. They are senior urologist who has performed thousands of retroperitoneal surgeries, such as ureterolithotomy, excision of renal cyst, and PN. To reduce the WIT, our team has been performing SAC in PN for selected cases. This study aimed to evaluate the preliminary results of retroperitoneal PN with SAC.

Methods

Clinical data

From December 2022 to May 2023, we recruited a total of five patients, including three men and two women, who underwent retroperitoneal laparoscopic partial nephrectomy with selective renal artery clamping. The median patient age was 32 years (range, 25–70 years). The selection criteria were patients with T1

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stage primary RCC who were eligible for laparoscopic surgery. Patients with a history of retroperitoneal surgery were excluded from this study. Surgeries were performed by surgeons with at least 10 years of experience in urological retroperitoneal surgery at a national tertiary hospital. Table 1 summarizes the patients' demographic data. Five patients with RCC without any obvious symptoms were diagnosed during a health checkup. The tumour diameters ranged from 3 to 4.5 cm (median, 3.5 cm). The R. E. N. A. L. scores were 4x, 5p, 8a, 5a, and 8ah. No pathological lymph node, renal vein, inferior vena cava tumour thrombus, or distant metastasis was noticed by imaging in any of the patients. Computed tomography angiography (CTA) was performed preoperatively to visualize the segmental arteries of the tumour (Fig. 1). Postoperative follow-up was performed at 1 and 6 months after surgery, including estimated glomerular filtration rate (eGFR) measurement, abdominal CT scan, and hemogram. The study was approved by the Institutional Review Board (IRB) of the current institution (IRB number: 16/GCN-HDDD) and was registered in the Research Registry. Informed consent was obtained from all study participants and their guardians before enrolment. In addition, the study was conducted in accordance with the PROCESS criteria[7].

Surgical methods

The patients were placed under general anaesthesia and positioned in the lateral decubitus position. To establish the retroperitoneal space, a 2-cm incision was made in the midline axillary line at the level of the iliac crest. An observation trocar was placed at this position. An adaption of retroperitoneal balloon was placed in the retroperitoneal space through the incision and inflated with ~800 ml air to expand the retroperitoneal space. Under the guidance of the camera via the trocar above, a 10-mm trocar was placed in the posterior axillary line just below the 12th rib. Two 5-mm trocars were placed along the anterior axillary line. The insufflation pressure was maintained at 15 mm Hg. The renal fascia and adipose capsule were opened along the posterior aspect of the kidney to expose the kidney, revealing the renal tumour and peripheral renal parenchyma. Instead of dissecting the renal artery trunk, we dissected several segmental arteries of the tumour directly near the renal parenchyma under the guidance of CTA (Fig. 2A). We used a vessel loop instead of a bulldog to clamp the branches of the renal vessels. The ischaemic border of the parenchyma was identified after clamping the segmental artery (Fig. 2B). The segmental arteries were clamped sequentially until the ischaemic border covered the entire renal tumour. The tumour was resected using scissors with an incision at least 2 mm away from the tumour. Renorrhaphy was performed using continuous suturing. A sliding Hem-O-Lok was used to fix and tighten the sutures. Subsequently, the segmental arteries were released to check for active bleeding. Finally, the resected tumours were placed in a specimen bag for removal, followed by drain placement and closure of the incision.

Table 1

Characteristics of patients.

Charecteristics	Case 1	Case 2	Case 3	Case 4	Case 5
Age (years old)	54	70	31	32	25
Sex	Male	Male	Male	Female	Female
BMI	24.3	25.2	26.1	21.9	20.5
Tumour size (cm)	3	4.5	3.5	4.5	3
TNM stage	T1a	T1b	T1a	T1b	T1a
R.E.N.A.L score	4x	5p	8a	5a	8ah

a, anterior; h, hilum; p, posterior; TNM, TNM staging system of renal cell carcinoma: the extent of the tumor (T), extent of spread to the lymph nodes (N), and presence of metastasis (M); x, neitheir.

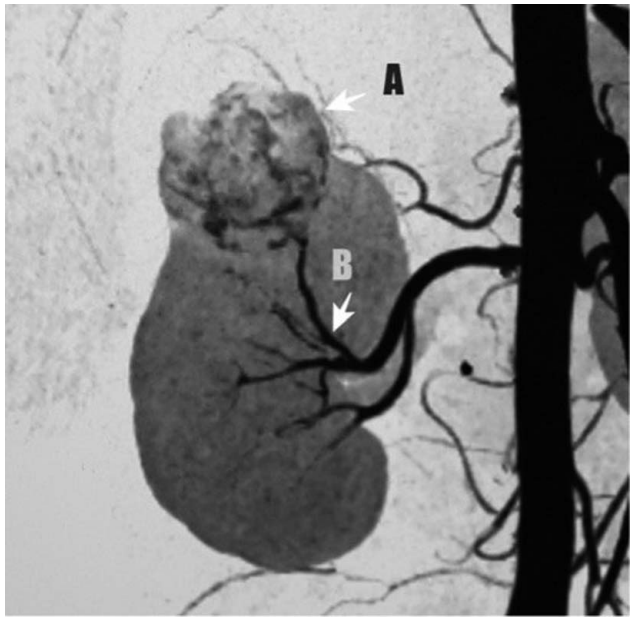

Figure 1. Computed tomography angiography was used to visualize the tumour segmental arteries. (A) The tumour is located at the upper pole of the kidney, (B): The segmental artery branches to the tumour.

Results

Five operations were successfully performed. Operative characteristics are presented in Table 2. One artery was clamped in four patients, while three were clamped in one patient. The median operation time was 120 min (range: 75 – 150 min), and the median warm ischaemia time was 22 min (range: 15 – 30 min). The median blood loss was 150 ml (range: 100 – 300 ml), and the median postoperative hospital stay was 5 days (range: 3 – 7 days). There were no perioperative complications. Clinicopathological analysis of the five tumours revealed two renal clear cell carcinomas, two papillary carcinomas, and one chromophobe carcinoma. All patients had negative margins. At the 6-month follow-up, there was no evidence of local recurrence or metastasis. The median preoperative eGFR was 96.9 ml/min (range: 80.5 – 105.2 ml/min), with a median decrease in eGFR after surgery of 6% (range: 4 – 30%).

Discussion

For stage T1 renal cell carcinoma, partial nephrectomy is the standard treatment modality[2]. Laparoscopic partial nephrectomy continues to be favored in resource-limited settings because of its cost-effectiveness while maintaining efficacy[8]. According to several studies, the criteria for an effective partial nephrectomy include a negative surgical margin, absence of complications, and minimal reduction in postoperative renal function, commonly referred to as achieving the "Trifecta"[9].

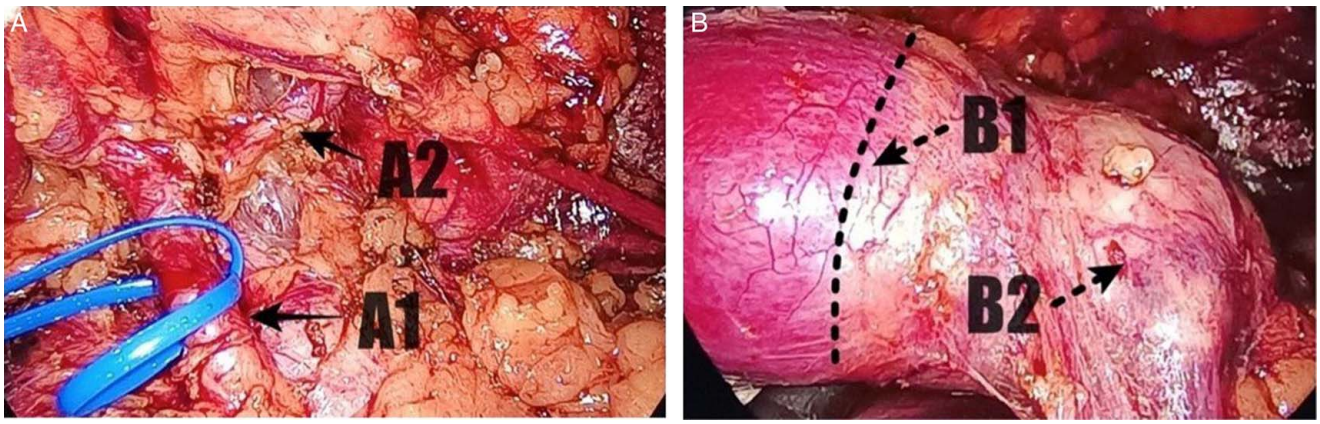

Figure 2. (A) Image of the segmental artery of the renal tumour (A1: Segmental artery. A2: Main renal artery). (B): Identification of the ischaemic boundary (B1: Boundary of the ischaemic tissue. B2: Ischaemic tissue containing the renal tumour).

First, surgeons must consider methods to perform PN, such as transperitoneal or retroperitoneal laparoscopy. It has been reported that the transperitoneal approach is optimal for anterior renal tumours, while the retroperitoneal approach is preferred for posterior renal tumours[10]. A meta-analysis conducted by Fu *et al.*[11] suggested that, among the two approaches, the retroperitoneal approach may shorten both the surgical time (mean difference = – 33 min) and hospital stay (mean difference = – 1.47 days) compared with the transperitoneal approach. In our study, three out of five patients had anterior renal tumours, and the retroperitoneal approach was chosen for all patients. There were two reasons for this decision. First, surgeons were familiar with retroperitoneal surgery. Second, the posterior approach facilitates the dissection of the renal artery and its branches. It was unable to compare our results with conventional transperitoneal laparoscopic PN with SAC, wherein robotic-assisted surgery was used in most studies.

Another controversial issue is whether selective clamping of the renal artery branches should be used. SAC helps to reduce the amount of parenchyma subjected to warm ischaemia. It is well known that WIT is a determining factor for the decline of renal function. However, selective clamping can prolong surgical time and increase blood loss[6]. Our experience has shown that all patients should undergo careful surgical planning using preoperative CTA imaging to identify the location and number of vessels to be clamped. In addition, during surgery, surgeons should prepare for excessive bleeding by having a backup plan to clamp the main renal artery if selective clamping fails. In the current cohort, vessel loops were used to expose the main renal arteries as a backup plan when selective vascular control failed.

The decision to perform selective clamping of multiple renal artery branches should be considered preoperatively and intraoperatively. In particular, if there are multiple branches supplying the tumour, clamping one artery may not provide adequate exposure to the surgical field because of bleeding[12]. In this case series, one patient had three artery branches that were clamped to provide a clear surgical field for renorrhaphy. In our opinion, surgeons should be flexible in their choice of clamping method and switch to clamping the main renal artery as soon as they encounter difficulties or risk excessive bleeding with selective clamping.

In our study, only one in five patients had a significant decrease in eGFR postoperatively. The patient had a tumour predominantly located in the parenchyma. This could prolong the time required for tumour dissection, parenchymal repair, and WIT, leading to renal injury. The study by Jian and colleagues is also consistent with this observation, showing that for T1b-stage

Table 2

Operative characteristics.

Characteristics	Case 1	Case 2	Case 3	Case 4	Case 5
Operation time (min)	75	150	70	120	150
No. clamped vessels	1	1	1	1	3
WIT (min)	22	30	15	20	30
Intraoperative blood loss (ml)	150	120	100	150	300
Preoperative eGFR	80.5	74.3	96.9	105.2	100.2
Postoperative eGFR	75.9	52.1	93.2	90.6	95.1
Decrease in eGFR (%)	6	30	4	13	5
Urine leakage	None	None	None	None	None
Pathology result	Clear cell RCC	Papillary RCC	Chromophobe RCC	Clear cell RCC	Papillary RCC
Resection margin	Negative	Negative	Negative	Negative	Negative
Drain duration (day)	3	4	3	2	4
Length of postoperative hospital stay (day)	5	7	4	3	5

eGFR, estimated glomerular filtration rate; RCC, renal cell carcinoma; WIT, warm ischaemic time.

tumours undergoing partial nephrectomy with selective arterial clamping, the E and N scores of the R.E.N.A.L score affect the change in GFR after surgery in the short term[13].

When comparing the advantages of SAC and main renal artery clamping (MAC) in terms of changes in eGFR after surgery, SAC tended to demonstrate superiority over MAC in improving eGFR during the follow-up period of less than 3 months in most studies. However, at the 6 months of follow-up, no discernible difference was observed between the two groups[5]. It is essential to note that the limitations of most studies include non-randomized controlled trials and insufficient follow-up durations. Only one RCT was conducted to monitor the efficacy between the two methods, but the follow-up duration was relatively short, lasting only 6 months[14].

An interesting parameter that should be included to monitor and compare the effectiveness of these two approaches is preserved parenchymal volume. To the best of our knowledge, using the search process in the Supplementary, only a few studies have included this parameter to assess its impact on postoperative renal function decline[14,15]. One study demonstrated that the preserved parenchymal volume was higher in the selective renal artery clamping group and that the eGFR in this group exhibited better results at the last follow-up[15].

We acknowledge the limitations of this study. First, only a small number of patients were involved, which limits our ability to draw conclusions based on statistical analysis. Second, the lack of a control group prevented the study from comparing the outcomes of retroperitoneal laparoscopic PN with SAC for RCC with other methods. Third, the follow-up duration was insufficient to confirm the long-term advantages of SAC. Larger, well-designed studies with controlled groups and long-term follow-up are needed to provide robust recommendations regarding the application of retroperitoneal laparoscopic PN with SAC in T1 stage RCC.

Conclusion

Retroperitoneal laparoscopic PN with SAC is a safe and effective treatment for T1 RCC. Although SAC has advantages over MAC in preserving renal function in the short term, evidence of the long-term advantages of SAC is unclear. Therefore, further RCTs with adequate follow-up durations are needed to provide treatment recommendations.

Ethical approval

This case series was approved by the Institutional Review Board (IRB) of the current institution (IRB number: 16/GCN-HDDD).

Informed consent

The patient in this study has given consent to be included.

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Author contribution

T.T.D., T.D.P., D.M.T., V.H.L., D.M.N., H.H.N., D.L.N., D.T.N., D.U.N.: management of the case and preparation of the manuscript. T.T.D., T.D.P., D.M.T., V.H.L., D.M.N., H.H.N., D.L.N., D.T.N., and D.U.N.: management of the case and critical appraisal and review of the manuscript. D.M.T., V.H.L., D.M.N., D.L.N., D.T.N., D.U.N.: visualization. All authors have read and approved the final manuscript.

Conflicts of interest disclosure

The authors declare no conflicts of interest regarding the publication of this article.

Research registration unique identifying number

1. Name of the registry: researchregistry.com.
2. Unique identifying number or registration ID: research registry9816.
3. Hyperlink to your specific registration (must be publicly accessible and will be checked): https://www.researchregistry.com/browse-the-registry#home/registrationdetails/657ec43aed4e8e0029c48acb/.

Guarantor

Truong-Thanh Do and Dao-Uyen Nguyen.

Data availability statement

Data could be obtained by requesting it from the corresponding author via e-mail.

Provenance and peer review

Not commissioned, externally peer-reviewed.

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References

[1] IARC. Globocan 2020 - Cancer Today. International Agency for Research on Cancer. https://gco.iarc.fr/today/en/fact-sheets-cancers
[2] Ljungberg B, Albiges L, Abu-Ghanem Y, *et al*. European Association of Urology Guidelines on Renal Cell Carcinoma: The 2022 Update. Eur Urol 2022;82:399–410.
[3] Mir MC, Ercole C, Takagi T, *et al*. Decline in renal function after partial nephrectomy: etiology and prevention. J Urol 2015;193:1889–98.
[4] Ng CK, Gill IS, Patil MB, *et al*. Anatomic renal artery branch microdissection to facilitate zero-ischemia partial nephrectomy. Eur Urol 2012;61:67–74.
[5] Xu J, Xu S, Yao B, *et al*. Segmental artery clamping versus main renal artery clamping in nephron-sparing surgery: updated meta-analysis. World J Surg Oncol 2020;18:210.
[6] Zhang L, Wu B, Zha Z, *et al*. Comparison of selective and main renal artery clamping in partial nephrectomy of renal cell cancer: A PRISMA-compliant systematic review and meta-analysis. Medicine (United States) 2018;97:e11856.
[7] Agha RA, Sohrabi C, Mathew G, *et al*. PROCESS Group. The PROCESS 2020 Guideline: Updating Consensus Preferred Reporting Of CasESeries in Surgery (PROCESS) Guidelines. Int J Surg 2020;84:231–35.
[8] Choi JE, You JH, Kim DK, *et al*. Comparison of perioperative outcomes between robotic and laparoscopic partial nephrectomy: a systematic review and meta-analysis. Eur Urol 2015;67:891–901.
[9] Bai N, Qi M, Shan D, *et al*. Trifecta achievement in patients undergoing partial nephrectomy: a systematic review and meta-analysis of predictive factors. International Braz J Urol 2022;48:625–35.

[10] Li Y, Huang L, Liu W. Surgical strategy of laparoscopic partial nephrectomy: it is more suitable to use transperitoneal approach in anterior tumor patients and retroperitoneal approach in posterior tumor patients. Front Oncol 2023;13. doi:10.3389/fonc.2023.1115668
[11] Fu J, Ye S, Ye HJ. Retroperitoneal versus transperitoneal laparoscopic partial nephrectomy: a systematic review and meta-analysis. Chinese Med Sci J 2015;30:239–44.
[12] Shao P, Qin C, Yin C, *et al*. Laparoscopic partial nephrectomy with segmental renal artery clamping: technique and clinical outcomes. Eur Urol 2011;59:849–55.
[13] Qian J, Li P, Qin C, *et al*. Laparoscopic partial nephrectomy with precise segmental renal artery clamping for clinical t1b tumors. J Endourol 2015; 29:1386–91.
[14] Long JA, Fiard G, Giai J, *et al*. Superselective ischemia in robotic partial nephrectomy does not provide better long-term renal function than renal artery clamping in a randomized controlled trial (EMERALD): should we take the risk? Eur Urol Focus 2022;8:769–76.
[15] Desai MM, de Castro Abreu AL uis, Leslie S, *et al*. Robotic partial nephrectomy with superselective versus main artery clamping: a retrospective comparison. Eur Urol 2014;66:713–19.