Original Article

Trans-retro-peritoneal laparoscopic partial nephrectomy for posterior hilar tumor: technical feasibility and preliminary results

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Background: Urologists still encounter challenges when it comes to the surgical management of tumors located on the posterior lip and posterior renal hilar region. We propose a trans-retro-peritoneal (TRP) technique to address the difficulties associated with posterior hilar tumors during retroperitoneal laparoscopic partial nephrectomy (LPN). Its efficacy was evaluated in a retrospective case-control study.

Methods: The patients with posterior hilar tumors (≤7 cm) that underwent retroperitoneal LPN were included. The TRP technique allowed the posterior hilar tumor completely visible by incising the ventral peritoneum and rotating kidney ventrally during retroperitoneal LPN, which was applied in 36 cases, while the conventional retroperitoneal LPN was performed in 22 cases. Perioperative data were analyzed to evaluate the efficacy of TRP-LPN.

Results: In TRP-LPN group, the TRP technique was successfully performed in all the patients without converting to open surgery or radical nephrectomy. The warm ischemia time was significantly shorter in TRP-LPN group than conventional LPN group (20.3 *vs.* 28.5 min, P<0.001). Furthermore, the mean estimated blood loss in TRR-LPN group was significantly less than that in conventional LPN group (86.5 *vs.* 90.9 mL, P<0.05). The mean operation time and recovery time of gastrointestinal function were similar between two groups. No severe complications occurred, and no positive surgical margin was found. The rate of Trifecta achievement was 50.0% (18/36) and 31.8% (7/22) respectively for TRP-LPN and conventional LPN (P=0.175). After mean follow-up of 21 months, no recurrence or metastasis occurred in all cases.

Conclusions: Our findings, as demonstrated by the Trifecta outcomes, support the feasibility and efficacy of TRP-LPN in managing posterior renal hilar tumors. This approach may be considered as an efficient option for surgical management of such tumors.

Keywords: Renal cell carcinoma; posterior hilar tumor; peritoneum; trans-retro-peritoneal technique (TRP technique); partial nephrectomy

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Introduction

Either a transperitoneal or retroperitoneal route can be used to accomplish laparoscopic partial nephrectomy (LPN) (1). The many advantages of the retroperitoneoscopic procedure include minimum abdominal interference and simplicity in treating the renal pedicle arteries. The lack of anatomical markers and the restricted operative space, however, create certain difficulties. Urologists continue to face difficulties in the surgical treatment of posterior lip tumors and posterior renal hilar tumors (2).

The retroperitoneal approach is more direct and suitable for the management of posterior hilar tumors, which are located behind the hilar vessels, without interference from the vessels. However, exposure of these tumors during retroperitoneal LPN can still be difficult in some cases, mainly due to the narrow retroperitoneal space (3). To address this challenge, we propose the trans-retroperitoneal LPN (TRP-LPN) to improve the exposure of posterior hilar tumors. In this retrospective case-control study, we introduce our experience of TRP-LPN and evaluate its feasibility and efficacy of managing the posterior renal hilar tumors by comparing with the conventional retroperitoneal LPN. We present this article in accordance with the STROBE reporting checklist (available at https://tau.amegroups.com/article/view/10.21037/tau-23-399/rc).

Highlight box

Key findings

- Proposal of a trans-retro-peritoneal (TRP) technique to address the difficulties associated with posterior hilar tumors.
- This technology makes the warm ischemia time of patients shorter and the average blood loss less.

What is known and what is new?

- Surgically removing tumors located on the posterior lip and posterior renal hilar region presents a challenge for urologists.
- The TRP technique enables better tumor access, facilitates kidney rotation for easier suturing, and provides a larger surgical field for surgery.

What is the implication, and what should change now?

- This study proposes a TRP technique to address the difficulties associated with posterior hilar tumors during retroperitoneal laparoscopic partial nephrectomy, and the efficacy was evaluated in a retrospective case-control study.

Methods

Patients

Patients with posterior hilar tumors (≤7 cm) who underwent retroperitoneal LPN and had renal cell carcinoma pathologically diagnosis were examined from January 2020 to December 2022. The definition of a posterior hilar tumor was that the single tumor locating on posterior side of the renal hilum, nearing to the major renal vessels but without renal vessel involvement. Finally, 22 cases that had standard retroperitoneal LPN were included in the control group, whereas 36 cases underwent TRP-LPN. Based on the R.E.N.A.L. (radius, exophytic/endophytic, nearness, anterior/posterior, location) nephrometry score, the preoperative computed tomography (CT) or magnetic resonance (MR) examination was assessed to determine the tumor characteristics, including tumor size, tumor location, and tumor complexity.

The ethical council of Changhai Hospital, Naval Medical University, authorized the trial (Registration No. CHEC2021-191), and all subjects gave written informed consent before enrolling in the study. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The data of patients' demographic characteristics, tumor sides, tumor sizes, R.E.N.A.L. scores, perioperative examination data, warm ischemic time, estimated blood loss, postoperative complications, and pathologic results were collected retrospectively. The estimated glomerular filtration rate (eGFR) was calculated using the Modification of Diet in Renal Disease (MDRD) formula. Postoperative eGFR was measured three months after the surgery. The modified Clavien-Dindo classification was used to objectively compare perioperative outcomes. The combination of warm ischemic time within 25 minutes, a negative surgical margin, and no surgical complications was referred to as a Trifecta result (4). Following surgery, every patient was monitored as per the European Association of Urology guideline's advice (5).

Operation procedures

All procedures were performed by the same experienced laparoscopic surgeon (Q.Y.) under general anesthesia following the same protocol. *Figures 1*,*2* showed the images

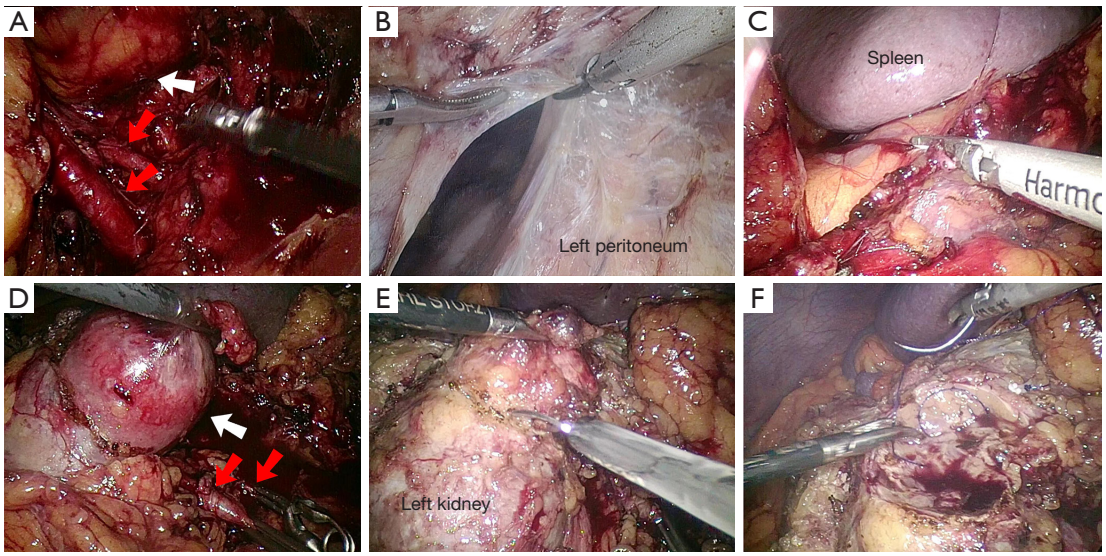

Figure 1 The procedures of TRP-LPN for posterior hilar tumor. (A) The posterior hilar tumor (white arrow) was adjacent to the renal artery (red arrows) and could not be exposed thoroughly; (B) the ventral peritoneum was incised at the weakness and up to the upper pole of kidney; (C) the peritoneum was extended down to the lower pole of kidney; (D) the anatomic relationship between tumor (white arrow) and renal artery (red arrows) was exposed clearly; (E) the posterior hilar tumor excision was performed; (F) the tumor bed was convenient to be sutured. TRP-LPN, trans-retro-peritoneal laparoscopic partial nephrectomy.

and schemas of TRP-LPN to manage posterior renal hilar tumor in left kidney as an example. Three ports were administered for posterior renal hilar tumors after patients were placed in a modified lateral decubitus posture. The retroperitoneal space was established using a handmade balloon dilator after a transverse incision was made at 2 cm above the iliac crest at the mid-axillary line. Under the direction of the surgeon's finger, the first 12 mm trocar was inserted around 2 cm below the rib angle. Through the incision above the iliac crest, the second 12 mm trocar was inserted for the camera. The last 12 mm trocar was positioned with the aid of the lens along the anterior axillary line, about 2 cm below the costal arch. Gerota's fascia incision was finished to enable access to the renal structures after the retroperitoneal fatty tissue was removed, and the renal arteriovenous were subsequently dissected (*Figure 1A*). The posterior renal hilum tumor could not be viewed properly by retroperitoneal laparoscopy from this vantage point. In contrast to the conventional retroperitoneal LPN, which involves direct tumor removal and kidney suturing, the TRP technique was performed as follows.

TRP technique

Initially, the ventral peritoneum was incised at the weakness (Toldt's line) and up to the hepatic flexure of the colon in the case of the right kidney. If necessary, the triangular ligaments were cut to dissociate the liver from the retroperitoneum and the hepatocolic ligaments were also cut to allow the free rotation of the kidney. For left kidney surgery, the peritoneum was incised up to the spleen upper edge and splenocolic ligament should be cut if necessary (*Figure 1B*). Further incisions were made in the peritoneum, reaching the kidney's lower edge (*Figure 1C*). With the removal of adipose tissue, the posterior portion of the kidney was divided at the border between the perirenal fat and the renal parenchyma. The kidney may also be turned ventrally either mechanically or by simple retraction. The intraperitoneal bowel would descend to the contralateral side under its own gravity. Consequently, the posterior hilar tumor was completely visible during retroperitoneal laparoscopy (*Figure 1D*). The partial nephrectomy was carried out after the standard renal artery clamping (and, in certain circumstances, renal vein clamping) (*Figure 1E,1F*). For certain cases, the early unclamping technique was performed after completing the first layer continuous suture of the wound bottom. The artery clamping clip was released to restore the renal blood supply, followed by the second layer continuous suture of the renal wound. After the partial nephrectomy, the peritoneum remained open without

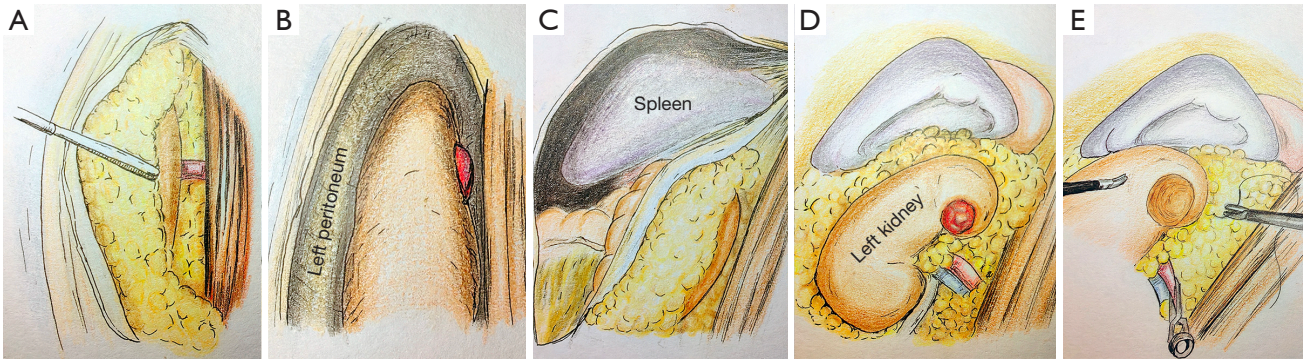

Figure 2 The schematic illustration of TRP-LPN. (A) The dissection of the renal arteriovenous; (B) the unsatisfactory observation of posterior renal hilum tumor. (C) The incision of ventral peritoneum at the weakness; (D) the full exposure of posterior renal hilar tumor; (E) the convenient suture of tumor bed after resection. TRP-LPN, trans-retro-peritoneal laparoscopic partial nephrectomy.

Table 1 Baseline characteristics and renal tumor characteristics of included patients

Variable	TRP-LPN group (n=36)	Conventional LPN group (n=22)	P value
Age, years, mean ± SD	57±6	60±8	0.110
Gender, n (%)			0.844
Male	27 (75.0)	17 (77.3)	
Female	9 (25.0)	5 (22.7)	
BMI, kg/m^2, mean ± SD	24.3±2.3	23.7±2.0	0.316
Preoperative eGFR, mL/min/1.73 m^2, mean ± SD	93.6±4.3	92.4±4.5	0.315
Tumor laterality, n (%)			0.536
Left	15 (41.7)	11 (50.0)	
Right	21 (58.3)	11 (50.0)	
Maximum tumor diameter, cm, mean ± SD	4.1±0.8	3.9±0.7	0.338
R.E.N.A.L score, mean ± SD	7±2	7±2	>0.99

TRP, trans-retro-peritoneal; LPN, laparoscopic partial nephrectomy; SD, standard deviation; BMI, body mass index; eGFR, estimated glomerular filtration rate; R.E.N.A.L., radius, exophytic/endophytic, nearness, anterior/posterior, location.

closing. The schematic illustration of TRP-LPN is depicted in *Figure 2*.

Statistical analysis

The data analyses were performed by SPSS software package version 22.0 (SPSS Inc., Chicago, IL, USA). The continuous parametric or nonparametric variables were compared using Student's successfully *t*-test or Mann-Whitney test, respectively. The categorical variables were compared using Pearson's Chi-squared test or Fisher's exact test. Statistically significant P value was set at 0.05 with two sides.

Results

Table 1 displays the baseline characteristics and kidney tumor characteristics of the individuals who were included in the study. All 36 patients, 27 men and 9 women, with a mean age of 57 (range, 36–72) years and a mean body mass index (BMI), of 24.3 (range, 20.5–27.8) kg/m^2 had TRP-LPN successfully. The mean tumor diameter in each case was 4.1 cm, with a range of 1.0 to 6.9 cm. All tumors were categorized as being of intermediate complexity since the mean R.E.N.A.L. score is 7 (range, 4–10). The control group consisted of 17 men and 5 women with an average

Table 2 Perioperative outcomes of TRP-LPN and conventional LPN

Variable	TRP-LPN group (n=36)	Conventional LPN group (n=22)	P value
Operation time, min, mean ± SD	106.3±15.7	110.5±19.2	0.368
Warm ischemia time, min, mean ± SD	20.3±5.6	28.5±8.2	<0.001
Estimated blood loss, mL, mean ± SD	86.5±7.1	90.9±7.9	0.032
Early unclamping, n (%)	7 (19.4)	2 (9.1)	0.459
Renal vein clamping, n (%)	1 (2.8)	1 (4.5)	>0.99
Operation conversion, n (%)	0	0	>0.99
Positive surgical margin, n (%)	0	0	>0.99
eGFR 3 months after surgery, mL/min/1.73 m^2, mean ± SD	74.5±9.5	73.9±10.0	0.820
Gastrointestinal function recovery, days, mean ± SD	1.9±0.8	1.7±0.6	0.317
Perioperative complications, n (%)			>0.99
Grade I–II	3 (8.3)	2 (9.1)	
Grade III–IV	0	0	

TRP, trans-retro-peritoneal; LPN, laparoscopic partial nephrectomy; SD, standard deviation; eGFR, estimated glomerular filtration rate.

age of 60 years, a mean BMI of 23.7 kg/m^2, a mean tumor diameter of 3.9 cm, and an average R.E.N.A.L. score of 7. The distributions of the aforementioned parameters between the TRP-LPN and traditional LPN groups did not differ significantly.

Table 2 compares the perioperative results of TRP-LPN and traditional LPN. In the TRR-LPN group, the mean warm ischemia time was 20.3 min, which was considerably less than the traditional LPN group's 28.5 min (P<0.001). Additionally, the mean estimated blood loss in the TRR-LPN group was considerably lower (86.5 *vs.* 90.9 mL, P<0.05) than that in the standard LPN group. However, no blood transfusion was necessary in any case. 19.4% (7/36) TRP-LPN cases and 9.1% (2/22) conventional LPN cases (P>0.05) had early unclamping. In neither group were any of the operations modified to open surgery or radical nephrectomy. The overall operating duration between the two groups did not differ significantly (106.3 *vs.* 110.5 min, P>0.05).

The eGFR significantly decreased in both groups immediately following LPN, but within three postoperative days, it rose back to baseline values in both groups (74.5 *vs.* 73.9 mL/min/1.73 m^2, P>0.05). Furthermore, there was no difference in the average recovery time for gastrointestinal function between the TRP-LPN group and the control group (1.9 *vs.* 1.7 days, P>0.05). Totally 5 patients experienced grade I–II complications, including 3 (8.3%) cases in TRP-LPN group and 2 (9.1%) in control group (P>0.05). Among them, there were two cases of hematuria that were managed conservatively. Pathological examination following the procedure revealed renal cell carcinoma in all cases with negative margins. The rate of Trifecta achievement was 50.0% (18/36) and 31.8% (7/22) respectively for TRP-LPN and conventional LPN (P>0.05). There were no instances of local recurrence or distant metastases during the average follow-up of 21 months.

Discussion

Renal tumors can be effectively managed via laparoscopy, utilizing either the anterior (transperitoneal) or posterior (retroperitoneal) approach. Transperitoneal laparoscopy, introduced in 1991 (6), has been widely used but the retroperitoneal approach introduced in 1994 (7) offers certain advantages. Gaur developed a balloon device in 1992 (8) for creating a retroperitoneal working space, demonstrating the benefits of this approach. It provides direct access to blood vessels supplying the tumor while avoiding bowel manipulation, which has led to an increased popularity of retroperitoneal laparoscopy in urologic surgery (9,10).

The meta-analysis found that retroperitoneal laparoscopy offers patients faster recovery after surgery and fewer postoperative complications compared to transperitoneal laparoscopy (11). The retroperitoneal approach may be especially suitable for obese patients or those with previous abdominal surgeries. However, the retroperitoneal space poses some challenges for surgeons. It is relatively confined,

lacking clear anatomic landmarks. Therefore, maintaining an adequate surgical workspace and operative view is critical for successful retroperitoneal laparoscopic procedures.

As we all know, the surgical difficulty of renal hilar tumors is significantly higher than that of non-hilar tumors (12,13). Eyraud *et al.* summarized that the technical difficulties include longer average operation and renal ischemic times, increased intraoperative blood loss, and a higher rate of intraoperative conversion to radical resection (14). For tumors located in the posterior hilar or lip region, the operating surgeon faces additional technical difficulties. Although the transperitoneal approach offers a larger working space, it may prove inadequate due to the tumor's position behind the hilar vessels, which hinders the tumor dissection and suture procedures. In contrast, the retroperitoneal approach is more suitable for posterior hilar tumors, yet in certain cases, it may still pose limitations in terms of tumor exposure (15).

In the field of retroperitoneal surgery, there is a theoretical proposal suggesting that enlarging the peritoneal tear could balance the pressure between the peritoneal and retroperitoneal spaces (16). However, determining the ideal extent of this enlargement is a significant challenge. If the tear is not widened enough, this could lead to an imbalanced pressure difference between the two spaces, resulting in less than optimal retroperitoneal space expansion. Conversely, if the tear is enlarged excessively, it might cause abdominal tissues and intestines to protrude into the retroperitoneal space, potentially causing harm during subsequent surgeries. Such damage could elevate the risk of bowel injury and postoperative intestinal adhesions (17). Prior to the current study (3), attempts were made to rotate the kidney ventrally without disrupting the peritoneum after completely separating the kidney from the fat layer during retroperitoneal LPN. Unfortunately, this method was deemed too time-consuming and did not sufficiently improve tumor exposure.

Eventually, the TRP technique, a new hybrid retroperitoneal and transperitoneal pure laparoscopic procedure, was employed. Despite this technique reducing the isolation of the retroperitoneal space, it notably eased the management of posterior hilar tumors during retroperitoneal LPN, especially for surgeons with limited experience in this specific procedure. The advantages of TRP technique of handling posteriorly located renal hilar tumors involves the following aspects: first, after the kidney descends to the abdominal side under its own gravity, surgeons can better access to the tumor location. This allows for a more accurate identification and visualization of tumor margins, facilitating precise tumor resection. Second, this approach facilitates kidney rotation, which simplifies the process of suturing following rotation. The ability to easily manipulate and suture the kidney contributes to the overall surgical feasibility and success. Third, the increased surgical field provides convenient access for renal artery clamping. It allows for efficient temporary arterial blood flow blockage to be performed, ensuring optimal control during the procedure.

The study had limitations including a small sample size, retrospective design and potential for treatment bias. However, there were no significant differences in patient or tumor characteristics between groups. Future large, well-designed multicenter trials are still needed to verify the feasibility, safety and effectiveness of the novel TRP technique for managing posterior hilar tumors.

Conclusions

By opening ventral peritoneum and rotating kidney ventrally in retroperitoneal LPN, the TRP technique allows for exposure of posterior hilar tumor at the center of clamp without interference from the bowel. Our preliminary results, as demonstrated by the Trifecta outcomes, support the feasibility and efficacy of TRP-LPN in managing posterior renal hilar tumors. This approach may be considered as an efficient option for the surgical management of such tumors.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The ethical council of Changhai Hospital, Naval Medical University, authorized the trial (Registration No. CHEC2021-191), and all subjects gave written informed consent before enrolling in the study. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013).

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