MEDICAL SCIENCE MONITOR

CLINICAL RESEARCH

e-ISSN 1643-3750
© Med Sci Monit, 2018; 24: 5147-5151
DOI: 10.12659/MSM.911199

Received: 2018.05.17
Accepted: 2018.07.13
Published: 2018.07.24

An Easy and Effective Method to Locate Renal Vein During Retroperitoneal Laparoscopic Radical Nephrectomy: Single-Center Experience

Authors' Contribution:
Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

BCDE 1 Lei Luo
BDF 1 Ya-Nan Liu
CD 2 Yan Zhang
EFG 1 Gui-Ming Zhang
FG 1 Li-Jiang Sun
BF 1 Yong Liu
ABCDEFG 1 Fang-Ming Wang

1 Department of Urology, The Affiliated Hospital of Qingdao University, Qingdao, Shandong, P.R. China
2 Division of Dyslipidemia, State Key Laboratory of Cardiovascular Disease, Fu Wai Hospital, National Center for Cardiovascular Diseases, Chinese Academy of Medical Sciences, Peking Union Medical College, Beijing, P.R. China

Corresponding Author: Fang-Ming Wang, e-mail: qingyifangming@163.com
Source of support: This work was supported by the Specialized Research Fund for the Doctoral Program of The Affiliated Hospital of Qingdao University (111520), awarded to Dr. Fang-Ming Wang, MD, PhD. This work was also supported in part by grants from the National Natural Science Foundation of China (No.81502195) awarded to Dr. Gui-Ming Zhang, MD, PhD, and No.81672512 awarded to Dr. Li-Jiang Sun, MD, PhD

Background: There are few studies that address how to quickly locate the renal vein after processing the renal artery during retroperitoneal laparoscopic radical nephrectomy (RLRN) for renal cell carcinoma (RCC). This study aimed to evaluate the feasibility of an easy and effective method to locate the renal vein in RLRN.

Material/Methods: Between September 2016 and October 2017, a total of 44 consecutive cases of RLRN were performed. All the surgeries used the proposed study method to locate the renal vein, in which surgeons located the renal artery following the medial arcuate ligament on the posterior abdominal wall, then the surgeon directly searched for the renal vein caudally relative to renal artery when performing left nephrectomy, but cranially when performing right nephrectomy.

Results: Among the 44 enrolled RLRN patients, there were 28 left nephrectomies and 16 right nephrectomies. We found the renal vein in most cases successfully by our proposed method. The renal vein was located caudally relative to the renal artery in 27 cases of the left kidney (96.4%), and was located cranially in 14 cases of the right kidney (87.5%). The mean operative time was 135.0±27.8 minutes. No intraoperative complications occurred. Postoperative complications (fever) developed in 5 patients. Pathological examination revealed: clear cell carcinoma in 34 cases (77.3%), chromophobe renal cell carcinoma (RCC) in 5 cases (11.4%), papillary RCC in 3 cases (6.8%), multilocular cystic RCC in 1 case (2.3%), and oxyphil cell adenoma in 1 case (2.3%).

Conclusions: Our proposed method to search for the renal vein might be a safe and feasible procedure to accelerate the process of handling the renal pedicle and of great practical significance in RLRN surgery.

MeSH Keywords: Carcinoma, Renal Cell • Laparoscopy • Nephrectomy • Renal Veins

Full-text PDF: https://www.medscimonit.com/abstract/index/idArt/911199

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Background

Renal cell carcinoma (RCC) is the third most common urological malignancy after prostate and bladder cancer [1]. Renal laparoscopic radical nephrectomy (RLRN) has gained wide acceptance as a standard treatment for RCC since it was first reported in 1991 [2]. The standard surgical treatment of renal cancers requires removal of the whole kidney and the perirenal fat and fascia, and even the adrenal gland in aggressive or metastasized cases [3]. It is of utmost importance to handle the renal pedicle during LRN. There are many ways to locate the renal artery. Some surgeons search and locate the renal artery by using ligaments on the posterior abdominal wall as landmarks to locate the renal artery quickly, while some first separate the ureter and then locate the renal hilum and then the artery following the ureter. After locating and processing the renal artery, urologists usually separated the fascia and other tissues neighboring the artery to expose the renal vein. However, to the best of our knowledge, studies addressing how to quickly locate the renal vein after dissecting the renal artery have not been reported. In our clinical practice, we found that the left renal vein usually appears on the caudal side of the renal artery, and the right renal vein usually appears on the cranial side of the renal artery under retroperitoneal laparoscopic. Accordingly, based on the aforementioned findings, we created an easy and effective method to locate the renal vein during LRN in the present study.

Material and Methods

Patient information

The study complied with the Declaration of Helsinki and was approved by our Institute Ethical Committee. Patient names, initials, or hospital numbers were not used in the text, table, or illustrative materials of this study.

From September 2016 to October 2017, 44 cases of RLRN were carried out using a standard 3-port technique. Patients with the diagnosis of renal vein thrombus or lymph node metastasis were not included in our study. Among the selected patients, no solitary kidney was present. They were 33 males and 11 females, ages ranged from 35 to 77 years (mean age was 58.2 years), weight ranged from 48 to 115 kg, height ranged from 156 to 180 cm, and body mass index (BMI) ranged from 18.8 to 39.1 kg/m^2 (mean BMI was 25.8 kg/m^2). All cases underwent enhanced computed tomography or magnetic resonance imaging examination. Among the tumors, 28 cases were found in the left kidney, and 16 cases in the right kidney. The maximum tumor diameter ranged from 2.8 to 12.0 cm (mean diameter was 6.0 cm). A total of 43 out of the 44 cases were renal carcinomas, among these carcinoma cases, case numbers 7, 19, 6, 3, and 8 were in stage T1a, T1b, T2a, T2b, and T3a respectively. Among all of the cases, 7 patients who were suitable for partial nephrectomy refused to receive nephron-sparing surgery.

All data on medical history, physical examination, laboratory test, tumor clinical stage at diagnosis, and treatment protocols were obtained from electronic records and medical charts. The baseline demographics and perioperative outcomes collected from all 44 patients are shown in Table 1.

Surgical procedures

The patient was placed in the full lateral decubitus position with overextension under general anesthesia. RLRN was performed using a standard 3-port technique by experienced surgeons, as previously described [4].

An incision of 1.5 cm was made from the posterior axillary line under the lower margin of the 12th rib, lumbodorsal fasciae were then dissected with vessel forceps, and the retroperitoneal space was expanded by blunt finger dissection. A homemade balloon dilator was then placed to create retroperitoneal space, and the first port was inserted into the retroperitoneal space. Two sutures were placed in this incision to avoid air leakage. After that, a pressure of pneumoperitoneum 12 mm Hg was maintained. A laparoscope was placed to observe the created space, under direct vision, one 12 mm camera port was placed 2 cm above the iliac crest at the mid axillary line, and the third port was placed at the anterior axillary line 2 cm below the costal arch.

After that, the retroperitoneal fat was removed, Gerota's fascia was then incised and the perinephric fat appeared. The psoas muscle, the diaphragm, and the medial arcuate ligament (MAL) on the posterior abdominal wall were subsequently found to be locate at the renal hilum. The renal artery was successfully found following the MAL on the surface of the psoas major muscle (PMM). When the renal artery was circumferentially mobilized and skeletonized, 3 Hem-o-lok® clips were easily placed on the renal artery, after which the procedure was then transacted safely (Figure 1). We further carefully separated the fascia and other tissues on the left side of the artery (caudal and cranial side relative to left and right artery, respectively) to a deeper level by using an ultrasound knife and surgical aspirator alternatively, and successfully exposed the renal vein (Figure 1). Then the vein was processed the same way as the renal artery. After handling the renal pedicle as described, we routinely performed a ureter dissection for completion of the nephrectomy dissection. After the specimen was removed, the incision was sutured.

Statistical analyses

Quantitative variables were expressed as mean ± standard deviation (SD) and were analyzed by the Student's *t*-tests.

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Table 1. Baseline characteristics of the study population.

Variables	Subjects (n=44)
Gender (n (%))	
Male	33 (75)
Female	11 (25)
Age (years)	58.2±10.0
BMI (kg/m^2)	25.8±4.0
Tumor location (n (%))	
Left	28 (63.6)
Right	16 (36.4)
Preoperative tumor size (cm)	6.0±2.2
Preoperative SCr (umol/L)	91.6±18.7
Postoperative SCr(umol/L)	101.1±25.8
Preoperative Hb (g/L)	143.0±16.1
Postoperative Hb(g/L)	127.2±13.5
Operative time (minutes)	135.0±27.8
Evaluated blood loss (ml)	152.7±209.6
Retroperitoneal drainage (days)	3.2±0.8
Postoperative hospital stay (days)	5.5±0.9
Complications (n (%))	5 (11.4)
Conversion rate (n (%))	1 (2.3)
Stage at diagnosis (n (%))	
T1a	7 (16.3)
T1b	19 (44.2)
T2a	6 (14.0)
T2b	3 (7.0)
T3a	8 (18.6)
M1	1 (2.3)
M0	43 (97.7)
Pathologic type (n (%))	
Clear cell carcinoma	34 (77.3)
Chromophobe renal cell carcinoma	5 (11.4)
Papillary renal cell carcinoma	3 (6.8)
Oxyphil cell adenoma	1 (2.3)
Multilocular cystic renal cell carcinoma	1 (2.3)
Fuhrman grading of clear cell carcinoma (n (%))	
Grade I	4 (11.8)
Grade II	22 (64.7)
Grade III	8 (23.5)
Grade IV	0

Data are expressed as n (%) or mean ±SD. BMI – body mass index; SCr – serum creatinine; Hb – hemoglobin.

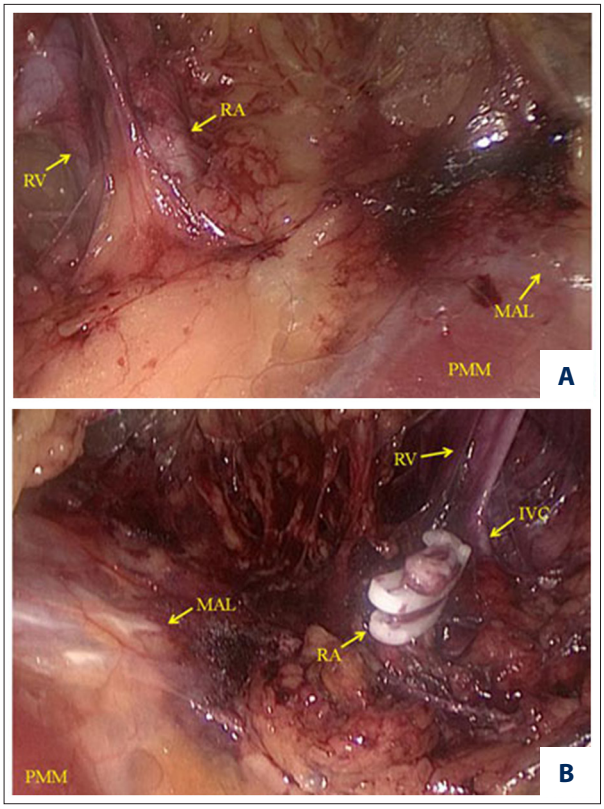

Figure 1. (**A**) The left side of retroperitoneal space after exposing the left renal hilum and separating the left renal artery (RA) and renal vein (RV); medial arcuate ligament (MAL) at the surface of psoas major muscle (PMM) is transversely close to the RA; the separated left RV is located in the caudal side of RA. (**B**) The right side of the retroperitoneal space after exposing the right renal hilum and separating the right RA and RV; MAL is also transversely close to the renal hilum; the separated right RV is located in the cranial side of RA; the right RA neighbors the inferior vena cava (IVC).

The qualitative variables were expressed as numbers and percentages and were analyzed by chi-squared statistic tests. A *P* value of less than 0.05 was considered statistically significant. Statistical studies were carried out with the SPSS program(version 19.0, SPSS, Chicago, IL, USA).

Results

All 44 procedures were performed successfully. Of these procedures, only one converted to an open radical nephrectomy due to a blocking artery revealed under laparoscopy, which was due to tumor adhesions, and the need for transfusion during the operation. The estimated intraoperative blood loss was approximately 20–1200 mL (average was 152.7 mL). The operation lasted from 75 to 195 minutes (average was 135 minutes). For all patients, the preoperative serum creatinine

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Table 2. The position of veins and other characteristics in left and right kidney.

Variables	Left kidney (n=28)	Right kidney (n=16)	P value
Gender (%)			
Male (%)	20 (71.43)	13 (81.25)	0.719
Female (%)	8 (28.57)	3 (18.75)	
Age (years)	57.2±11.0	59.9±7.9	0.391
BMI (kg/m^2)	26.6±4.5	24.5±2.6	0.104
Preoperative tumor size (cm)	5.7±1.8	6.3±2.9	0.436
Operative time (minutes)	131.3±29.7	141.6±23.6	0.241
Evaluated blood loss (ml)	94.4±57.7	229.4±315.8	0.110
Position of Vein(s)			**<0.001**
Caudally relative to the artery	27 (96.4)	1 (6.3)	
Cranially relative to the artery	0	14 (87.5)	
The same level relative to the artery	1 (3.6)	1 (6.3)	

Data are expressed as n (%) or mean ±SD. The bold *p* values indicate statistical significance. BMI – body mass index.

(SCr) (91.6±18.7 umol/L) and the postoperative SCr (101.1±25.8 umol/L) was significantly different (*P*=0.001). No patient required dialysis due to renal insufficiency. The drainage tube was removed after 2–5 days (3.2±0.8 days). The patients started to get out of bed for activities 1–2 days after the surgery, and the mean postoperative hospital stay was 4–8 days (5.5±0.9 days). This group of 44 patients had no operation-related complications. Five postoperative fevers occurred. No urinary tract infection, ileus, or hemorrhage occurred. The 5 patients with fever recovered with active surveillance and treatment. Postoperative pathology confirmed that among the 44 cases, clear RCC cases were mostly of the conventional cell type (n=34; 77.3%), the most common of which were grade II tumors (n=22; 64.7%). The most common tumor classification was clinical stage T1b tumors (n=19; 44.2%). One distant metastasis was discovered. Detailed patients' intraoperative and postoperative outcomes are shown in Table 1.

Using our surgical technique, after mobilizing the dorsal and lateral side of the kidney adequately, we could observe the quadratus lumborum, PMM, and MAL on the posterior abdominal wall under retroperitoneal laparoscope. Since MAL on the surface of PMM pointed to the renal hilum, we could recognize the eminence of the renal pedicle near the inner side of this ligament, then we could expose the renal artery after processing the eminence which was composed of fibrous fascia and fat. After ligating and cutting the renal artery, we searched for the renal vein. There was an evident difference between the left side and right side regarding the relative position of the renal artery and vein. When performing left nephrectomy, we found the renal vein by separating the tissues on the caudal side of the renal artery to the deep layer (27 out of 28 cases, 96.4%). However, when performing right nephrectomy, we exposed the renal vein by separating the tissues on the cranial side of the renal artery to the deep layer (14 out 16 cases, 87.5%) (Table 2).

In accordance with the positioning of these muscles and ligaments, and the relative positioning of arteries and veins in our findings, we successfully processed the renal pedicles in a short time period and completed the radical nephrectomy.

Discussion

LRN has gained wide acceptance as a standard treatment for RCC without affecting the oncologic outcome [5–8]. Compared with a transperitoneal approach, a retroperitoneal approach permits faster access to the renal artery [9] and achieves early ligature of the renal artery. In addition, there is little confusion for surgeons in distinguishing the renal artery from the abdominal arteries in the retroperitoneal approach. Therefore, we routinely choose the retroperitoneal approach for LRN. Although the retroperitoneal laparoscope technique is widely used in LRN, there is still a wide area for further development. Many surgeons are now focusing on modification and development of the laparoscopic technique.

Previous retroperitoneal techniques dissected, ligated, and divided renal vessels after the entire mobilization of the kidney (dorsal and abdominal side, upper and lower pole). Afterwards, some urologist first processed the renal vessels after mobilizing the dorsal side and lateral side of the kidney adequately [10]. Most studies include the location of renal artery during retroperitoneal laparoscopic surgeries. Xu Zhang and colleagues [11]

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described their experience locating the renal artery quickly, according to abdominal muscles and ligaments, which is a technique widely applied by urologists.

There are few studies regarding the positioning of the renal vein. Generally speaking, surgeons searched for the renal vein around the already dissected renal artery, aimlessly, and paid little attention to the relative position of renal artery and vein under retroperitoneal laparoscope. With our modified method, after processing of the renal artery, we directly searched for the renal vein caudally relative to the artery when performing left nephrectomy, and directly searched for the renal vein cranially relative to the artery when performing right nephrectomy. In this way, we received satisfactory outcomes by exposing the renal vein, and proved our theory regarding the position of renal veins. In this report, we first used the posterior abdominal muscles and ligaments to locate the renal artery, and then successfully located the renal vein according to the relative position of the renal artery and vein, which appeared to be a safe, time-saving procedure in our clinical practice.

Local anatomy indicates that the renal vein is located directly anterior to the renal artery, although this position can vary up to 1 to 2 cm cranially or caudally relative to the artery [12]. However, in our clinical practice, under retroperitoneal laparoscope, we observed that the renal vein is usually located directly anterior to the renal artery, and this position is about 1 to 2 cm caudally relative to the artery in the left kidney, but is about 0.5 to 1 cm cranially relative to the renal artery in the right kidney in most cases (the variant incidence is higher in the right kidney). In other words, the appearance of the renal vein and relative position to the renal artery under retroperitoneal laparoscope is a little different from that in transperitoneal surgery. We believed that the difference may be caused by the pulling of the kidney in the cranial direction during operation and the visual angle. In addition, we observed the gap between the left renal artery and vein was wider than that of the right renal artery and vein. We reviewed the literature and found that compared with the right renal vein, the left renal vein enters the inferior vena cava at a slightly more cranial level and a more anterolateral location [12]. This might explain the gap difference.

We believed that the neighboring and relative position between the renal vein and the renal artery under retroperitoneal laparoscope in our study has a solid anatomical basis. Therefore, surgeons may use our modified method to achieve positioning of the renal vein during RLRN and other upper urinary tract laparoscopic surgeries that require handling of the renal pedicle.

There were several limitations in our study. First, it was conducted at a single center. Although the 44 cases summarizing our clinical experience proved our theory, the limited sample size may reduce the strength of the study. Second, due to the preference of the surgeon and anatomical differences, we could not apply our method to the transperitoneal approach. Third, a disadvantage of this method might be a difficulty in the presence of hilar adhesion or a large renal tumor, which could result in displacement of the renal pedicle's position.

Conclusions

The data from our study reveals for the first time that the renal vein is usually located caudally relative to the renal artery in the left kidney, and cranially in the right kidney, under retroperitoneal laparoscope. We could almost always search for and find the renal vein according to this method. Our initial experience suggests that our proposed procedure might be a safe and feasible procedure to accelerate the process of handling the renal pedicle, and might be of greater practical significance for the relatively narrow operating space in RLRN surgery.

Conflict of interest

None.

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