Retroperitoneal laparoscopic radical nephrectomy in the treatment of renal cancer: a 5-year single-center experience in resource-scare setting

Nguyen Minh An,[1-3] Ngo Trung Kien,[2] Nguyen Van Duc,[2] Vo Hoang Long[4]

[1]Hanoi Medical College, Hanoi; [2]Department of Urology, Saint Paul General Hospital, Hanoi; [3]Department of Surgery, Thai Binh University of Medicine and Pharmacy, Thai Binh; [4]Department of Science, Technology, Communication & International Cooperation, E Hospital, Hanoi, Vietnam

Correspondence: Nguyen Minh An, Saint Paul General Hospital, Hanoi 100000, Vietnam.
E-mail: dr.minhanxp@yhn.edu.vn ; drminhanhmc@gmail.com

Key words: renal cell carcinoma; renal cancer; retroperitoneal laparoscopic surgery; radical nephrectomy.

Acknowledgments: first of all, we sincerely thank all patients enrolled in this study. Also the authors would like to express their gratitude to the health staffs who are working at Saint Paul General Hospital (Hanoi, Vietnam).

Contributions: NMA, NTK, concept/design, data collection; NMA, NTK, VHL, data analysis/interpretation, drafting article; NMA, NTK, NVD, critical revision of article; NVD, data analysis/interpretation; VHL, statistics. All the authors approved the final version to be published.

Conflict of interest: the authors declare no potential conflicts of interest.

Funding: none.

Ethical approval and consent to participate: the study was approved by the Institutional Review Board of Saint Paul General Hospital.

Availability of data and material: the datasets used and/or analyzed during the current study are available upon reasonable request from the corresponding author.

Informed consent: informed consent was waived owing to the study's retrospective nature.

Received: 28 June 2024.
Accepted: 1 July 2024.

Licensee PAGEPress, Italy
Italian Journal of Medicine 2024; 18:1764
doi:10.4081/itjm.2024.1764

ABSTRACT

Based on a retrospective hospital-based analysis, this study examines the results of retroperitoneal laparoscopic radical nephrectomy for patients with T1-T2 renal cell carcinoma (RCC) from January 2019 to December 2023. Of the 73 patients, 4.1% had TNM stage II tumors and 95.8% had TNM stage I tumors (53.4% T1a and 42.4% T1b). In terms of frequency, clear cell RCC accounted for 84.9%, with papillary RCC coming in at 9.6% and chromophobe RCC at 4.1%. Following surgery, four patients experienced fevers, one needed a blood transfusion, two had infections, and one had emergency surgery. Lumbar masses and hematuria were absent in all patients. Subsequent metastatic lesions and abnormalities of the renal fossa were not observed on follow-up ultrasounds. 4.1% of the deaths after 25.9 months were due to the disease, and 1.4% were caused by accidents. At one, two, three, and four years, the cumulative survival rates were 100%, 97.2%, and 92.8%, respectively. 48.1 months was the mean postoperative survival period. For RCC stages T1-2, retroperitoneal laparoscopic radical nephrectomy offers significant benefits and comparable results to open surgery.

Introduction

Renal cell carcinoma (RCC) is an insidious neoplasm, representing about 2.4% of all malignancies in adults. In 2020, GLOBOCAN reported over 400,000 new cases and approximately 180,000 deaths from RCC worldwide.[1] RCC commonly occurs in people aged 50-70, with 1.5 times as many cases in males as in females.[1] The cause of RCC is not really clear, but many risk factors have been mentioned such as smoking, obesity, and hypertension.[2,3]

The incidence rates of RCC have been rising, particularly in higher-income regions.[4] The age-standardized rate (ASR) is 4.6 for the world average overall; 6.1 for men and 3.1 for women.[1] North America had the highest incidence at 12.2, followed by Australia and New Zealand at 10.2, and Europe at 9.5. ASRs in Asia and Africa were low at 2.8 and 1.8, respectively.[1] In Vietnam, the incidence rate of RCC was estimated to be 1.2%. In 2020, approximately 180,000 people died from RCC, representing 1.8% of all cancer deaths, with 116,000 men and 64,000 women among the deceased.[1] Mortality rates were higher in Eastern Europe and Latin America,[1] but no data were reported for Vietnam.

Symptoms of RCC are varied and often subtle, typically manifesting in the advanced stages of the disease. More than 50% of cases are detected incidentally through diagnostic imaging performed for unrelated conditions or other abdominal diseases. The 5-year survival rate for RCC is estimated to be between 74% and 81% for stages I and II, 54% for stage III, and drops to just 8% for stage IV. Despite the variety of treatment options available for RCC, surgical intervention remains a critical component of management.[5]

In lower-middle-income countries, particularly in Vietnam, surgical treatment remains the primary standard for kidney cancer, as other treatments have not proven to be effective.[6,7] Laparoscopic nephrectomy, first performed by Clayman *et al*. in 1990, revolutionized minimally invasive renal tumor treatment.[8] Currently, laparoscopic radical nephrectomy is the standard for localized renal tumors unsuitable for partial nephrectomy.[9] The advantages of laparoscopic surgery over open surgery are well-documented in recent studies.[9] However, the safety and feasibility of laparoscopic surgery for advanced tumors remain subjects of ongoing debate.

Despite the implementation of retroperitoneal laparoscopic radical nephrectomy for the treatment of RCC in many institutions across Vietnam, available reports on experience and outcomes remain limited. Hence, to fill this knowledge gap, this study sought to review our large single-center experience in radical nephrectomy via the retroperitoneal laparoscopic approach for Vietnamese patients with RCC within five years. The present approach experience of ours are helpful to healthcare providers for the effective management of RCC.

Materials and Methods

Study design and patients

The study was reviewed and approved by our institutional ethical review boards and informed consent was obtained from the patients. This is a retrospective hospital-based review of perioperative and postoperative outcomes of patients who were diagnosed with T1-T2 stage RCC and underwent radical nephrectomy via the retroperitoneal laparoscopic approach between January 2019 and December 2023. We carried out this retrospective review for the data collection within January 2024. A total of 73 consecutive patients who met the selection criteria were included in the study.

The clinical profile, preoperative characteristics, intraoperative events, and postoperative outcomes were abstracted from the database of our center.

Data analysis

Data was first performed by a visual inspection for coding errors, outliers, or funky distributions. All statistical analyses were performed with Stata® 15 (StataCorp LLC, USA). Main descriptive statistics were reported as absolute and relative (%) frequencies for categorical variables or as means with their standard deviation or median and min and max values depending on the normality of the distribution.

Results

Of 73 patients with RCC, 43 were male and 30 female. Their mean age was 53.52±12.17 years (20 years to 84 years). Hypertensin was in 10 patients (13.7%), smoking in 38 patients (52.1%), and overweight and obesity in 16 patients (21.9%). Functional symptoms included lower back pain (63.0%), hematuria (50.1%), and both lower back pain and hematuria (9.6%). Palpable mass was in 1 case (1.4%). Systemic symptoms included fever (1.4%), weight loss (1.4%), poor appetite (10.9%), and anemia (5.5%).

Preoperative laboratory findings of blood count parameters are revealed in Table 1. The average red blood cell count (RBC) was 4.82±0.76 T/L, the smallest RBC was 3.01 T/L, and the largest RBC was 7.12 T/L. The number of patients with normal RBC were 82.5%. The average WBC was 8.31±2.39 G/L, the lowest was 5.1 G/L, and the highest was 14 G/L. Patients with leukocytosis were 20.2%. 44% had normal hemoglobin levels, while 32.2% had decreased hemoglobin. Most patients had normal hemoglobin levels (44%), while 32.2% of patients had decreased hemoglobin levels. Biochemical blood tests indicated elevated blood urea nitrogen in 2 patients (2.7%), elevated blood creatinine in 4 patients (5.5%), and hypokalemia in 17 patients (23.5%).

Patterns by renal ultrasound were hyperechoic (47.9%), free (15.1%), hypoechoic (24.6%), and mixed (12.4%). Ultrasound findings revealed that 47.9% of tumors were less than 4 cm, 52.1% were between 4 and 7 cm, and there were no tumors larger than 7 cm. The average tumor size by ultrasound was 42.08±10.0 mm. The average tumor size measured by the computed tomography (CT) scan was 43.21±11.7 mm, with the largest tumor measuring 72 mm and the smallest tumor measuring 20 mm. Patterns by CT were hyperechoic (23.7%), free (31.7%), hypoechoic (18.4%), and mixed (26.3%). All tumors were localized and had not breached the renal capsule. Of the patients, 63.01% had tumors in the left kidney, and 36.99% had tumors in the right kidney. No patients had tumors in both kidneys.

70 patients had a TNM stage I tumor (95.8%), of which 53.4% were T1a and 42.4% were T1b renal tumors. Three patients had a TNM stage II tumor (4.1%). Histopathological classification revealed the most was clear cell RCC (84.9%), while others were papillary RCC in 7 patients (9.6%), and chromophobe RCC in 3 (4.1%).

Table 2 shows the intraoperative events, procedures, and parameters. 51 patients were used with 2 trocars (69.8%), while 22 patients received 3 trocars (30.2%). 13 patients had multiple vascular branches, primarily involving multiple arterial branches. Among these 13 patients, 5 had an additional superior polar artery, 3 had an additional inferior polar artery, 4 had a renal artery that bifurcated early into two smaller branches entering the renal hilum, and 1 case had a renal vein confluence close to the entry into the inferior vena cava. Among the 73 kidneys resected due to tumors, 83.56% had only one artery, which was clamped with three Hemolocks before transection. Twelve patients had additional arterial branches; the number of Hemolocks used (either 2 or 3) before transection depended on the size of these branches. In the study, 72 kidneys had only one renal vein, which was clamped with three Hemolocks before transection. One kidney had a branch confluence close to the inferior vena cava, which was

managed as two veins, with three Hemolocks on each branch before transection. Smaller vascular branches and gonadal vein branches were clamped and transected using either Hemolocks or titanium clips, depending on the vessel size. We encountered 5 patients occurred bleeding complications during surgery. The operative blood loss was 235±102 ml and the operative duration was 106.7±25.1 mins.

Table 3 indicates the outcome and complications after retroperitoneal laparoscopic radical nephrectomy. The mean duration of analgesic use, duration of flatulence, and duration of drainage tube removal were 2.5±1.4 days, 1.6±0.5 days, and 1.7±1.0 days. The mean duration of hospital stay was 6.2±1.7 days. Postoperatively, 2 patients experienced infections at the trocar site, 4 patients had fevers, 1 patient

Table 1. Preoperative characteristics of the study population.

	All patients (n=73) Count	% of total
Gender - %		
Male	43	58.9
Female	30	41.1
Age group (years) - %		
≤40 years	9	12.3
41-60 years	35	47.9
61-80 years	28	38.4
>80 years	1	1.4
Patient age (years) - mean±SD (Min-Max)	53.52±12.17 (20-84)	
Personal medical history		
Hypertension - %	10	13.7
Smoking - %	38	52.1
Overweight and obesity - %	16	21.9
Functional symptoms		
Lower back pain - %	46	63.0
Hematuria - %	38	50.1
Both lower back pain and hematuria - %	7	9.6
None - %	9	12.3
Physical signs		
Palpable mass - %	1	1.4
Systemic symptoms		
Fever - %	1	1.4
Weight loss - %	1	1.4
Poor appetite - %	8	10.9
Anemia - %	4	5.5
None - %	59	80.8
RBC (T/L) - %		
Increased (>5 T/L)	9	12.5
Normal (3-5 T/L)	60	82.5
Decreased (<3 T/L)	4	5.0
WBC (G/L) - %		
Increased (>10 G/L)	15	20.2
Normal (5-10 G/L)	53	73.8
Decreased (<5 G/L)	5	6
Hemoglobin (g/L)		
Increased (>15 g/L)	17	23.8
Normal (13-15 g/L)	32	44.0
Decreased (<13 g/L)	24	32.2
Hematocrit (%)		
Increased (>40 %)	40	54.8
Normal (30-40 %)	31	42.2
Decreased (<30 %)	2	2.4
BUN (mmol/L)		
Increased (>7.5 mmol/L)	2	2.7
Normal (2.5-7.5 mmol/L)	71	97.3
Blood creatinine (μmol/L)		
Increased (>120 μmol/L)	4	5.5
Normal (<120 μmol/L)	69	94.5
Blood potassium (mmol/L)		
Increased (>4.5 mmol/L)	0	0
Normal (3.5-4.5 mmol/L)	56	76.5
Decreased (<3.5 mmol/L)	17	23.5
Pattern by renal ultrasound		
Hyperechoic	35	47.9
Free	11	15.1
Hypoechoic	18	24.6
Mixed	9	12.4
Tumor size by ultrasound		
<4 cm	35	47.9
4-7 cm	38	52.1
>7 cm	0	0.0
Tumor size by ultrasound (cm) - mean±SD	42.08±10.0	
Tumor size by computed tomography		
<4 cm	36	49.3
4-7 cm	34	46.6
>7 cm	3	4.1
Tumor size by computed tomography (cm) - mean±SD	42.08±10.0	
Pattern by computed tomography - %		
Hyperechoic	17	23.7
Hypoechoic	13	18.4
Free	23	31.7
Mixed	20	26.3
Tumor boundary - %		
Localized in the renal capsule	73	100.0
Breaching the capsule	0	0.0
Calcified renal cell carcinoma - %	11	15.1
Kidney tumors by computed tomography - %		
Upper pole	31	42.5
Mid pole	15	20.5
Lower pole	27	37.0
Tumor location - %		
Right kidney	27	36.9
Left kidney	46	63.1
Both kidneys	0	0.0
TNM staging		
T1a	39	53.4
T1b	31	42.5
T2a	2	2.7
T2b	1	1.4
Histopathological classification		
ccRCC	62	84.9
pRCC	7	9.6
crRCC	3	4.1
Others	1	1.4

RBC, red blood cells; WBC, white blood cells; BUN, blood urea nitrogen, SD: standard deviation; TNM, tumor, nodes, and metastases; ccRCC, clear cell renal cell carcinomas; pRCC, papillary renal cell carcinomas; crRCC, chromophobe renal cell carcinomas.

required a blood transfusion due to postoperative bleeding, and 1 patient underwent emergency open surgery immediately after returning to the recovery room due to bleeding through the drain. The postoperative complication rate according to the Clavien-Dindo classification was 10.9% (8 patients).

As was also shown in Table 4, 47 out of 73 patients were documented at the follow-up visit. No patients had hematuria or a mass in the lumbar region. 5 patients experienced unexplained lumbar pain, and 2 patients reported a decline in their health after surgery. The ultrasound results at the follow-up examination showed no abnormalities in the renal fossae and no evidence of secondary metastatic lesions in any of the patients. At the follow-up visit, several laboratory findings of blood count parameters were measured in 47 patients.

Among the 73 patients contacted postoperatively, 69 patients (94.5%) were still alive, 3 patients (4.1%) had died due to the disease, and 1 patient (1.4%) had died due to a traffic accident. The mean follow-up period was 25.9±12.7 months (range: 3.2-49.9 months). The cumulative survival rates at 1 year, 2 years, 3 years, and 4 years after retroperitoneal laparoscopic radical nephrectomy in the treatment of renal cancer were 100%, 100%, 97.2%, and 92.8%, respectively. The mean postoperative survival time was 48.1±1.0 months (Table 5).

Table 2. Intraoperative characteristics.

	All patients (n=73) Count	% of total
Number of trocars - %		
2 trocars	51	69.8
3 trocars	22	30.2
Renal artery and vein morphology - %		
1 renal artery and 1 renal vein	60	82.2
Multiple branches	13	17.8
Renal artery management - %		
Clamped with 3 Hem-o-Lok clips	61	83.5
Clamped with more than 3 Hem-o-Lok clips	12	16.5
Renal vein management - %		
Clamped with 3 Hem-o-Lok clips	72	98.6
Clamped with more than 3 Hem-o-Lok clips	1	1.4
Complications		
Bleeding - %	5	6.8
Injury to other organs - %	0	0.0
Conversion to open surgery - %	0	0.0
Mortality - %	0	0.0
Operative blood loss (ml) - mean±SD	235±102	
Operative duration (mins) - mean±SD	106.7±25.1	

SD, standard deviation.

Table 3. Postoperative characteristics.

	All patients (n=73) Count	% of total
Duration of analgesic use (days) - mean±SD	2.5±1.4	
Duration of flatulence (days) - mean±SD	1.6±0.5	
Duration of drainage tube removal (days) - mean±SD	1.7±1.0	
Duration of hospital stay - %		
<5 days	14	19.2
5-7 days	47	64.4
>7 days	12	16.4
Duration of hospital stay (days) - mean±SD	6.2±1.7	
Complications		
Bleeding - %	1	1.4
Fever - %	4	5.5
Surgical site infection - %	2	2.7

SD, standard deviation.

Table 4. Re-examination characteristics.

	All patients (n=47) Count	% of total
Clinical symptoms at the time of re-examination		
Lower back pain - %	5	6.8
Hematuria - %	0	0.0
RBC (T/L) - %		
Increased (>5 T/L)	4	8.5
Normal (3-5 T/L)	39	83.0
Decreased (<3 T/L)	4	8.5
WBC (G/L) - %		
Increased (>10 G/L)	8	17.0
Normal (5-10 G/L)	36	76.6
Decreased (<5 G/L)	3	6.4
Hemoglobin (g/L)		
Increased (>15 g/L)	7	14.9
Normal (13-15 g/L)	36	76.6
Decreased (<13 g/L)	4	8.5
Hematocrit (%)		
Increased (>40 %)	10	21.3
Normal (30-40 %)	33	70.2
Decreased (<30 %)	4	8.5
BUN (mmol/L)		
Increased (>7.5 mmol/L)	3	6.4
Normal (2.5-7.5 mmol/L)	44	93.6
Blood creatinine (μmol/L)		
Increased (>120 μmol/L)	4	8.6
Normal (<120 μmol/L)	43	91.4
Blood potassium (mmol/L)		
Increased (>4.5 mmol/L)	0	0.0
Normal (3.5-4.5 mmol/L)	38	80.9
Decreased (<3.5 mmol/L)	9	19.1

Table 5. Mortality after retroperitoneal laparoscopic radical nephrectomy.

	All patients (n=73) Count	% of total
Death after surgery - %		
Disease-related death	3	6.8
Death from other causes	1	1.4
Survival	69	91.8
Postoperative follow-up time (months) - mean±SD	25.9±12.7	
Postoperative survival time (months) - mean±SD	48.1±1.0	

Discussion

The purpose of the surgery is to remove the entire tumor, the ipsilateral kidney, and the surrounding perirenal fat. Robson comprehensively introduced the method of radical nephrectomy for renal cancer, reporting a survival rate of 66% in stage I and 64% in stage II.[10] This approach completely replaced simple nephrectomy in the treatment of renal cancer.[10] Novick, in his efforts to treat patients with radical nephrectomy for renal cancer, demonstrated a 5-year survival rate ranging from 40% to 68%.[11] Radical nephrectomy is accepted based on the principles of early control of the renal artery and vein, removal of the kidney along with the perirenal fat and Gerota's fascia, ipsilateral adrenalectomy, and regional lymph node dissection from the diaphragm to the bifurcation of the abdominal aorta. After nephrectomy, only the muscle layer posteriorly, the diaphragm superiorly, the major vessels anterior to the spine medially, and the peritoneum or intra-abdominal organs anteriorly remain. However, there are differing opinions on whether to adhere strictly to these principles. Sagalowsky suggests that only 25% of localized renal cancers invade the perirenal fat, making the removal of both the perirenal fat and Gerota's fascia unnecessary in all cases.[12] Additionally, Dimarco reported that in tumors larger than 10 cm, with necrosis and hemorrhage, high histopathologic grade, and stages pT3 and pT4, only 0.6% to 10% had lymph node metastasis.[13] Despite ongoing debates, most authors agree that adhering strictly to the principles of radical nephrectomy increases postoperative survival chances for patients.

Radical nephrectomy can be performed either through open surgery or laparoscopic surgery. Numerous studies worldwide have compared the survival times of renal cancer patients who underwent laparoscopic versus open surgery. The results consistently indicate no difference in postoperative survival time. Meanwhile, the benefits of laparoscopic surgery for patients are evident: reduced pain, less blood loss, shorter hospital stays, faster recovery, and improved aesthetics. With advancements in technology and expertise, laparoscopic surgery is increasingly being applied in medical facilities for early-stage cancer.

Clayman conducted transperitoneal laparoscopic nephrectomy to treat renal tumors.[14] Hemal *et al.* reported 41 cases of laparoscopic nephrectomy for renal cancer.[15] Studies consistently show that laparoscopic surgery has advantages over open surgery in terms of simpler postoperative care, better pain management, and superior aesthetics. Consequently, laparoscopic nephrectomy is increasingly being recommended. According to the updated August 2014 European Association of Urology guidelines, laparoscopic radical nephrectomy shows no difference in oncological outcomes compared to open surgery. Laparoscopic nephrectomy is recommended for patients with RCC stage T2 or lower.[16] A few authors have performed nephrectomy for T3 stage tumors, but the number of patients is limited. In the present study, we performed retroperitoneal laparoscopic nephrectomy for patients diagnosed preoperatively with RCC stage T1a (53.4%), stage T1b (42.4%), stage T2a (2.8%), and stage T2b (1.4%).

Transperitoneal laparoscopy offers the advantage of easily determining Trocar placement, providing a wider operative field due to clearer and more easily identifiable anatomical landmarks such as the liver, spleen, and diaphragm. However, it carries the risk of injury to intra-abdominal organs and is challenging in cases of adhesions from previous surgeries or abdominal infections. Retroperitoneal laparoscopy has the advantage of avoiding complications associated with the transperitoneal approach, such as bowel adhesions, Trocar site hernia, and injury to the intestines and other intra-abdominal organs. Nonetheless, the retroperitoneal approach has its drawbacks. Firstly, it is difficult to perform in patients with previous retroperitoneal surgery. Secondly, the operative field is limited due to the narrower retroperitoneal space. Thirdly, the presence of fatty tissue limits access to the kidney and exposure of the renal hilum, making kidney dissection and specimen retrieval more challenging, thus requiring more advanced surgical skills. In this study, when performing retroperitoneal laparoscopic radical nephrectomy for the treatment of renal cancer, we found that 3 or 4 trocars could be used depending on the condition of the retroperitoneal space and perirenal adhesions. 51 patients (69.86%) were operated on using 3 trocars, and 22 patients (30.14%) were operated on using 4 trocars.

The comprehensive report by Eskicorapci *et al.* has highlighted multiple studies demonstrating no significant differences in the efficacy of transperitoneal and retroperitoneal nephrectomy.[17] Both surgical approaches have similar complication rates, postoperative pain management needs, hospital stays, and recovery times. Specifically, Desai's report indicates that both transperitoneal and retroperitoneal laparoscopic nephrectomy yield comparable results regarding blood loss, intraoperative and postoperative complications, and hospital stay duration.[18] However, differences were noted between the retroperitoneal and transperitoneal groups in terms of operative time (150 minutes *vs*. 207 minutes, P=0.001), faster renal artery control (34 minutes *vs*. 91 minutes, P<0.0001), and quicker renal vein control (45 minutes *vs*. 98 minutes, P<0.0001).[17] Nowadays, transperitoneal and retroperitoneal laparoscopic nephrectomy have become standard procedures in urological oncology surgery, adhering to the principles of no-touch technique and minimal invasiveness. Several authors advocate for the retroperitoneal approach due to advantages such as early renal artery control and reduced risk of injury to intra-abdominal organs like the digestive tract. Others emphasize the benefit of a larger operative field with the transperitoneal approach. Overall, discussions indicate that both transperitoneal and retroperitoneal laparoscopic nephrectomy are effective for cancer treatment, but the choice of technique depends on the surgeon's preference and experience.

There are three approaches to exposing the ureter and renal pedicle: i) the first approach involves locating the kidney, lifting it to expose and manage the renal pedicle first, and then cutting the ureter; ii) the second approach involves identifying the ureter first, cutting and lifting it to expose and manage the renal pedicle, and finally dissecting the perirenal fat; iii) the third approach involves incising the Gerota's fascia, locating the renal pedicle first, and then dissecting the kidney and cutting the ureter. Laparoscopic nephrectomy presents some differences between right and left kidney removal. After creating the retroperitoneal space, the ureter is located by following its peristalsis, which leads to the renal hilum, and dissection of the gonadal vein is unnecessary. When exposing the renal pedicle, the renal artery is posterior to the renal vein. The artery and

vein are dissected separately, with the artery being clipped and cut first, followed by the renal vein. Hemostasis must be ensured by using two Hemolock clips on the central side and one on the peripheral side, ensuring complete vessel occlusion. Dissection of the perirenal fat is continued, and hemostasis is achieved using titanium clips for small vessels or electrocautery. Finally, the ureter is dissected downward and cut. For the 46 cases of left nephrectomy, after creating the retroperitoneal space, the renal pedicle is exposed. The left renal artery and vein are also dissected separately, with the artery being clipped and cut before the vein. The left adrenal vein and left gonadal vein are also clipped and cut. After cutting the left renal artery and vein, the kidney and perirenal fat are freed, and the ureter is dissected and cut at a lower level. The entire specimen, including the tumor-bearing kidney, ureter, and perirenal fat, is placed in a nylon bag for removal.

Among the 73 kidneys excised due to tumors, 83.56% had only one artery, which was clamped using three Hemolocks before excision. Twelve patients had accessory arterial branches, which were clamped with an additional two or three Hemolocks, depending on the branch size, before cutting the vessels. The study observed that 72 kidneys had only one renal vein, which was clamped with three Hemolocks before excision. One kidney had a branch confluent with the vena cava, treated as having two veins, each clamped with three Hemolocks before cutting. The adrenal branches, gonadal vein branches, and perirenal fat vein branches were clamped using Hemolocks or Titanium clips, depending on the vessel size. In cases of thick perirenal fat or inflammatory adhesion at the renal hilum, dissection was challenging, posing a risk of bleeding and prolonging hemostasis. In some instances, open surgery was required for hemostasis and nephrectomy.

Open nephrectomy and laparoscopic nephrectomy, whether retroperitoneal or transperitoneal, have distinct advantages and inherent risks. Common complications include bleeding, vascular injuries, damage to abdominal and thoracic organs, difficulty converting to open surgery, and mortality. In our study, we encountered five patients (6.8%) with intraoperative bleeding complications: one case of renal artery injury, two cases of renal vein tear, one case of upper pole accessory artery bleeding, and one case of adrenal artery bleeding. The average blood loss was 235±102 ml, with no cases requiring conversion to open surgery or experiencing organ injury or intraoperative death. Laparoscopic nephrectomy complications, particularly bleeding and vascular injuries, are well-documented. Dense perirenal fat and adhesion at the renal hilum pose significant risks for renal artery and vein injuries, as well as an accessory artery, gonadal vein, or even aorta-caval injuries. If not managed promptly, these injuries necessitate conversion to open surgery. Eskicorapci *et al*. summarized multiple reports and found intraoperative bleeding in 2%, pulmonary embolism in 1%, and ileal stenosis in 1%, with an average blood loss of 140 ml (range 100-700 ml).[17] Wille (2004) noted an intraoperative complication rate of 8%, with an average blood loss of 210 ml.[19] Cicco *et al.*'s study of 29 retroperitoneal laparoscopic nephrectomies reported one case (3.4%) of intraoperative bleeding requiring conversion to open surgery, with an average blood loss of 150 ml.[20] Hemal *et al.* reported 7.3% intraoperative bleeding in 41 patients, with 4.9% needing conversion to open surgery for renal pedicle hemostasis.[21] In cases of dense perirenal fat or difficult dissection of the renal hilum, patient repositioning, additional trocar placement, and enhanced exposure are necessary. If difficulties persist, conversion to open surgery should be considered to ensure patient safety. Abdominal organ injuries are another potential complication; Cicco *et al.* reported one case requiring a colostomy due to colon injury among 29 patients.[20] In our current study, no patients experienced organ or gastrointestinal tract injuries during surgery. Specimen retrieval involved extending the incision by 3-5 cm or joining two trocar sites, with the kidney and tumor placed in a plastic bag for extraction, maintaining structural integrity for pathological examination.

The surgical duration is measured from the initial skin incision to the final skin suture. It depends on numerous factors such as tumor size, invasion of surrounding tissues, presence of venous thrombosis, surgical approach, patient's body condition (thin or obese), and the surgeon's experience. A shorter surgical duration typically leads to quicker postoperative recovery. Additionally, the duration reflects the ease or difficulty of the procedure. In our study, most patients had a surgical time of less than 120 minutes, with only five patients exceeding two hours. The average surgical time was 106.72±24.1 minutes. This aligns with other studies, such as Eskicorapci *et al.*, who reported an average duration of 135 minutes (90-410 minutes),[17] and Cicco *et al.*, with an average of 145 minutes (80-330 minutes).[20] Tumors located at the lower pole tend to facilitate surgery, potentially reducing the duration compared to upper pole tumors. The renal pedicle dissection typically consumes the most time, especially in patients with large tumors, which obscure the renal hilum and increase the risk of bleeding, thus prolonging the surgery. For large tumors, surgeons may extend the incision for nephrectomy and tumor retrieval in a plastic bag (by joining two trocar sites or making a subcostal incision), preserving the kidney's structure and renal hilum, ultimately reducing the surgical time.

In laparoscopic nephrectomy, the incidence of postoperative complications is very low. Among these, postoperative bleeding is frequently highlighted in studies due to its association with the surgeon's experience.[22] In reality, postoperative bleeding complications due to vascular injuries commonly occur in areas such as the adrenal gland dissection site, gonadal vein stump, adrenal vein stump, and ureteral stump. In this study, postoperative complications classified according to the Clavien-Dindo system were observed in 8 patients (11%). Among them, 2 patients (2.7%) experienced infection at the expanded trocar site on the third postoperative day, which was managed with dressing changes; 4 patients (5.5%) developed fever on the fifth postoperative day, treated with antibiotics and antipyretics; 1 patient had persistent bleeding through the drain from the second to the fifth day, with a daily output of 80-120 ml of diluted blood, managed with monitoring and blood transfusion; and 1 patient had significant bleeding through the drain immediately after returning to the recovery room, with a total of 400 ml. This patient underwent emergency open surgery for hemostasis, where it was found that the cause of bleeding was a slipped renal artery clip. According to Bilgo *et al.*, who conducted laparoscopic nephrectomies on 68 patients from 2017-2019 for both tumors and benign kidneys, postoperative complications according to the Clavien-Dindo classification were 22%, including wound infection (10.3%),

pain and fever (5.9%), bleeding requiring transfusion (4.4%), and mortality in 1 patient (1.5%).[23] Eskicorapci *et al.* reported a 5% postoperative complication rate.[17] Balcı *et al.*, in a study of laparoscopic nephrectomy on 208 patients from 2008-2015, found a Clavien-Dindo postoperative complication rate of 6.3%, with grades 1, 2, and 3 complications at 1.4%, 4.3%, and 0.5%, respectively.[24]

A postoperative evaluation revealed that 65 patients (89%) had favorable outcomes, with the majority of tumors being in stage T1 (95.8%) and smaller than 7 cm. During surgery, five patients experienced bleeding, which was managed intraoperatively without the need for conversion to open surgery, and the average surgical duration was short. These results are consistent with those reported by other authors. For patients with average postoperative outcomes, 7 out of 73 patients (9.6%) fell into this category. These surgeries were more challenging, with durations exceeding 120 minutes in 5 patients due to tumors larger than 7 cm (1 patient) or stage T2 tumors (3 patients), and 1 patient required a blood transfusion due to postoperative bleeding. Only 1 patient (1.4%) had a poor postoperative outcome. This patient experienced significant bleeding (400 ml) through the drain immediately after returning to the recovery room, necessitating emergency open surgery for hemostasis. The cause of the bleeding was identified as a slipped renal artery clip. Following the secondary surgery, the patient stabilized and was discharged on the eighth day.

We observed that tumors were typically located at one pole of the kidney, with the upper pole being the most common at 42.1%. No cases of multiple tumors in the kidney were noted. The tumor location distribution in this study is consistent with previous research. In recent years, there has been an increase in the detection of smaller tumors. This trend is attributed to the rising incidence of incidental tumor detection, increasing health awareness in the community, and early detection of kidney cancer when tumors are small and in early stages. All patients in our study were diagnosed at stages T1-T2, with the majority being at stage T1 (95.8%). The predominant histopathological type was clear cell carcinoma (83.6%), while less common types included chromophobe cell carcinoma (5.5%), papillary cell carcinoma (8.2%), and other types (2.7%). According to Weiss and Storkel (1997), clear cell carcinoma accounts for approximately 70-80% of cases, papillary cell carcinoma for 10-15%, chromophobe cell carcinoma for 4-5%, and oncocytoma for 3-7%. Our histopathological findings align with those of other authors and the literature, where RCC constitutes up to 90% of kidney cancers.

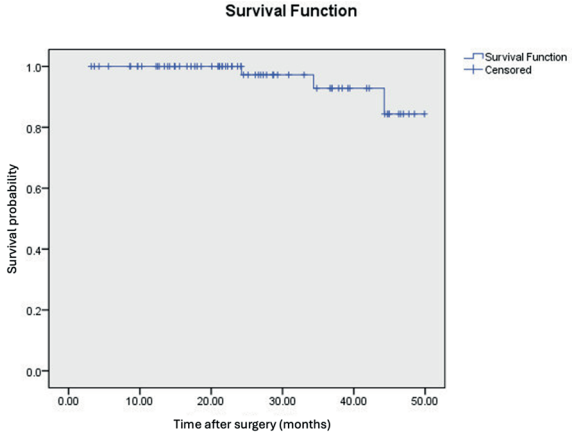

Figure 1. Kaplan-Meier estimated survival after retroperitoneal laparoscopic radical nephrectomy.

At the follow-up visit, patients underwent a clinical examination, ultrasound, and basic laboratory tests. If any abnormalities were detected, additional specialized tests such as CT scans were performed. As this is a retrospective study, we did not follow patients periodically but calculated the time from surgery to the follow-up visit. In our study, most patients showed no clinical or basic laboratory abnormalities at the follow-up. With an average follow-up duration of 25.96 months, at the time of follow-up, 69 patients (94.5%) were still alive, 3 patients (4.1%) had died due to the disease, and 1 patient (1.4%) had died due to a traffic accident. Survival analysis following laparoscopic radical nephrectomy for treating stage T1-T2 RCC using the Kaplan-Meier algorithm revealed a 4-year survival rate of 92.8% (Figure 1).

Our findings are consistent with those of other authors. Eskicorapci *et al.* reported overall survival rates of 92-94% at 5 years for stage pT1/2 N0M0 and 75% for stage pT3, with a mean follow-up of 75 months.[17] In Eskicorapci *et al.*'s report,[17] various stages of RCC were summarized, showing 5-year survival rates from other authors: Ono (2000) reported 92% survival at 5 years in 103 cases, Chan (2001) reported 95% survival at 5 years in 67 cases of stages T1-T3b, Gill (2001) reported 92% survival at 5 years in 100 cases of stages T1-T3b, and Saika reported 91% survival at 5 years in 195 cases of stage T1.[17] According to Portis,[25] follow-up after laparoscopic and open radical nephrectomy for treating stage T1-T2 RCC showed mean follow-up times of 54 months and 69 months, respectively. Kaplan-Meier analysis indicated 5-year survival rates of 92% for laparoscopic and 91% for open surgery, with no statistically significant difference observed. Overall, laparoscopic radical nephrectomy for RCC treatment yields survival outcomes equivalent to open surgery. Our study did not compare outcomes of laparoscopic radical nephrectomy after partial nephrectomy for localized RCC with other techniques such as laparoscopy during partial nephrectomy or open surgery. However, our results are consistent with studies by other authors conducting radical nephrectomy across different surgical techniques.

Conclusions

Retroperitoneal laparoscopic radical nephrectomy for RCC stages T1-2 demonstrates outcomes on par with open surgery, offering notable advantages. We advocate for retroperitoneal laparoscopic radical nephrectomy as the preferred approach for managing stage I and II renal tumors.

References

1. World Health Organization (WHO). Global Health Estimates 2020: Deaths by Cause, Age, Sex, by Country and by Region, 2000-2019; WHO: Geneva, Switzerland, 2020.
2. Lipworth L, Morgans AK, Edwards TL, et al. Renal cell cancer histological subtype distribution differs by race and sex. BJU Int 2016;117:260-265.
3. Makino T, Kadomoto S, Izumi K, Mizokami A. Epi-

demiology and prevention of renal cell carcinoma. Cancers 2022;14:4059.
4. Capitanio U, Bensalah K, Bex A, et al. Epidemiology of renal cell carcinoma. Eur Urol 2019;75:74-84.
5. Ljungberg B, Bensalah K, Bex A, et al. Guidelines on renal cell carcinoma. European Association of Urology 2015.
6. De Meerleer G, Khoo V, Escudier B, et al. Radiotherapy for renal-cell carcinoma. Lancet Oncol 2014;15:e170-e177.
7. Gunnarsson O, et al. Evaluating the safety and efficacy of axitinib in the treatment of advanced renal cell carcinoma. Cancer Manag Res 2015:65-73.
8. Clayman RV, Kavoussi LR, Soper NJ, et al. Laparoscopic nephrectomy. New Eng J Med 1991;324:1370-1.
9. Ljungberg B, Albiges L, Abu-Ghanem Y, et al. European association of urology guidelines on renal cell carcinoma: the 2019 update. Eur Urol 2019;75:799-810.
10. Robson CJ. Radical nephrectomy for renal cell carcinoma. J Urol 1963;89:37-42.
11. Novick AC, Jackson CL, Straffon RA. The role of renal autotransplantation in complex urological reconstruction. J Urol 1990;143:452-7.
12. Sagalowsky AI, Kadesky KT, Ewalt DM, Kennedy TJ, et al. Factors influencing adrenal metastasis in renal cell carcinoma. J Urol 1994;151:1181-4.
13. Dimarco DS, Lohse CM, Zincke H, et al. Long-term survival of patients with unilateral sporadic multifocal renal cell carcinoma according to histologic subtype compared with patients with solitary tumors after radical nephrectomy. Urology 2004;64:462-7.
14. Clayman RV, Kavoussi LR, Soper NJ, et al. Laparoscopic nephrectomy: initial case report. J Urol 2017;197:S182-S186.
15. Hemal A, Kumar A, Kumar R, et al. Laparoscopic versus open radical nephrectomy for large renal tumors: a long-term prospective comparison. J Urol 2007;177:862-6.
16. Peyronnet B, et al. Oncological outcomes of laparoscopic nephroureterectomy versus open radical nephroureterectomy for upper tract urothelial carcinoma: an European Association of Urology guidelines systematic review. Eur Urol Focus 2019;5:205-23.
17. Eskicorapci SY, Teber D, Schulze M, et al. Laparoscopic radical nephrectomy: the new gold standard surgical treatment for localized renal cell carcinoma. Scientific World Journal 2007;7:825-36.
18. Desai MM, et al. Prospective randomized comparison of transperitoneal versus retroperitoneal laparoscopic radical nephrectomy. J Urol 2005;173:38-41.
19. Wille AH, Roigas J, Deger S, et al. Laparoscopic radical nephrectomy: techniques, results and oncological outcome in 125 consecutive cases. Eur Urol 2004;45:483-9.
20. Cicco A, Salomon L, Hoznek A, et al. Results of retroperitoneal laparoscopic radical nephrectomy. J Endourol 2001;15:355-9.
21. Hemal A, Wadhwa SN, Kumar M, Gupta NP. Transperitoneal and retroperitoneal laparoscopic nephrectomy for giant hydronephrosis. J Urol 1999;162:35-9.
22. Elsamra S, Pareek G. Complications of laparoscopic renal surgery. Int J Urol 2010;17:206-14.
23. Bilgo A, Saouli A, Karmouni T, et al. Laparoscopic nephrectomy: Moroccan experience of 68 cases. Afr J Urol 2021;27:70.
24. Balcı M, Tuncel A, Güzel Ö, et al. Evaluation of the complications in transperitoneal laparoscopic renal and adrenal surgery with Clavien-Dindo classification. Turkish J Urol 2016;42:70.
25. Portis AJ, et al. Long-term followup after laparoscopic radical nephrectomy. J Urol 2002;167:1257-62.