

Comparison of the Clinical Efficacy of Retroperitoneal Laparoscopic Partial Nephrectomy and Radical Nephrectomy for Treating Small Renal Cell Carcinoma: Case Report and Literature Review

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Abstract

Background: Renal cell carcinoma (RCC) is a common malignancy of the urinary system with high rates of morbidity and mortality.

Objectives: This study aimed to investigate and analyze the clinical efficacy of retroperitoneal laparoscopic partial nephrectomy and laparoscopic radical nephrectomy for the treatment of small RCC.

Methods: In this retrospective study of 45 patients with small RCC, the patients were divided into two treatment groups: Group A (retroperitoneal laparoscopic partial nephrectomy, 25 cases) and Group B (retroperitoneal laparoscopic radical nephrectomy, 20 cases).

Results: There were no statistically significant differences in the operative time, amount of intraoperative blood loss, length of hospital stay, preoperative creatinine level, postoperative creatinine level after 24 hours, and survival rate after 1, 2, and 3 years between the two groups ($P > 0.05$).

Conclusions: There were no significant differences in the survival rates and short-term postoperative complications between the laparoscopic partial nephrectomy group and the laparoscopic radical nephrectomy group for small RCC, but the former was slightly more effective.

Keywords: Post-Laparoscopic Partial Nephrectomy, Retroperitoneal Laparoscopic Radical Nephrectomy, Small Renal Cell Carcinoma

1. Background

Renal cell carcinoma (RCC) is a common malignancy of the urinary system that carries high rates of morbidity and mortality (1). RCC is not sensitive to radiotherapy (2), chemotherapy (3), or hormone therapy (4); immunotherapy may produce some effects in advanced RCC or as a postoperative immunotherapy (5), but surgical resection is the currently accepted protocol for the early treatment of small RCC (6). Patients have disclosed a preference for minimally invasive surgery, and laparoscopic nephrectomy was also the optimal choice for RCC (7).

In 1967, Robson reported the first RCC radical nephrectomy (RN), which soon became the most important treatment for renal carcinoma at that time and was widely used in the following decades. Following the first successful laparoscopic resection of a renal tumor, which was reported by Clayman et al. in 1991, laparoscopic radical nephrectomy (LRN) has been increasing in use to treat RCC (8). An

increasing number of urologists use the LRN procedure (9, 10), which has come to replace open surgery in the treatment of localized RCC (11).

In recent years, with the development of medical imaging and advanced surgical techniques as well as the timely diagnosis of early RCC (12), nephron-sparing surgery (NSS) has gained more attention. Numerous studies have shown that there are many advantages of NSS, such as protecting the nephron, producing fewer complications, and improving patients' quality of life; this procedure is also associated with a lower recurrence of RCC and a longer survival time compared to older approaches (13).

Laparoscopic surgical procedures for the treatment of RCC include LRN and LPN through either an abdominal or retroperitoneal approach, with the latter being most common. Determining the most effective and appropriate surgical method has been a long-term focus of study in urology departments. This comparative study was designed to contrast the two surgical methods using a retroperitoneal

approach (LRN vs. LPN) and determine whether LPN has advantages over LRN, which would implicate it as the preferred surgical method in clinical practice.

2. Objectives

This study aimed to investigate and analyze the clinical efficacy of retroperitoneal LPN and LRN for the treatment of small RCC.

3. Methods

3.1. Clinical Data

A retrospective study of 45 patients with small RCC IA was conducted within the Urology Department of our hospital between July 2008 and April 2012. The cohort included 30 men and 15 women from 19 - 66 years of age (mean age: 50.5 ± 10.4 years). In all cases, small RCC was diagnosed using ultrasonography, intravenous urography, and computed tomography (CT) prior to surgery. Of the 45 cases, 31 were left-sided kidney cancer and 14 were right-sided kidney cancer. This study was conducted in accordance with the Declaration of Helsinki and also with the approval of the ethics committee of 187 hospitals of PLA. Written informed consent was obtained from all participants before the study began. The patients were divided into two treatment groups: Group A (retroperitoneal LRN, 25 cases) and Group B (retroperitoneal LPN, 20 cases). There were no statistically significant differences between the two groups (Table 1), which suggested that no obvious confounding variables were present.

3.2. Surgical Methods

3.2.1. Group A

In the retroperitoneal LPN procedure, artificial pneumoperitoneum was first established. Then, 12 intercostal lumbar incisions were made. Dissection continued into the Gerota fascia, and the entire kidney in the deep face of the fascia was freed. The tumor and the peri-renal fat were resected together. In most cases, temporary renal artery occlusion was performed to reduce bleeding and tissue swelling. Adequate fluids were administered to prevent renal ischemic injury. Mannitol was intravenously infused to promote diuresis for about 5 min before blocking the artery.

A multivariate analysis performed by Pouliot et al. (14) showed that a warm ischemia time of up to 30 min had little effect on renal function. Therefore, during LPN, care should be taken to focus on reducing the resection of the normal renal parenchyma and ensuring negative margins

rather than prematurely loosening the vascular clamp. Increased renal damage was observed after 30 minutes. Reducing the risk of renal damage was our first consideration. Because the estimated time of renal ischemia was > 30 minutes, the local temperature was decreased by injecting sterile saline around the kidneys during laparoscopy through a 12-mm trocar passageway that contained a cannula. After 10 minutes, the surface temperature of the kidney was $12 - 18^{\circ}\text{C}$. The forceps were clamped, and a timer was started, thereby reducing renal injury; an intravenous infusion of inosine was also administered. Partial renal resection was then performed. Attention was paid to protect the portion of the renal fascia that was connected to the tumor during resection, but the surface of the tumor and the surrounding normal adipose tissue were resected. A ring insertion of the normal kidney tissue outside the tumor of the false capsule was made, and the tumor was resected.

Partial nephrectomy of the tissue in the upper and lower poles was performed with a negative margin of 0.5 - 1.0 cm. After resection, the tumor was sent for pathological analysis to confirm the cutting margin. Small renal vessels on the kidney wound were sutured with 3-0 absorbable line in a figure eight fashion. If the edge of the partial nephrectomy reached the renal pelvis, tight suturing with 4-0 absorbable line was performed to avoid postoperative urinary leakage. After packing absorbable hemostatic gauze into the kidney wound, continuous suturing with 2-0 absorbable line was performed on the renal parenchyma. A kidney drainage tube was placed, and the drainage volume was recorded. A double-J stent was implanted preoperatively within the renal pelvis. A double-J stent was also implanted if damage to the renal pelvis was found; all stents were removed by cystoscopy 1 month later.

3.2.2. Group B

A retroperitoneal LRN approach was used for patients in Group B. The patients were placed in the flank position under general anesthesia. Three 10-mm tube operating channels were created at the waist. First, in the midline direction, the psoas fascia and extracapsular gap of the kidney fat layer were separated from the renal fascia. For patients lying on their right flank, the gonadal vein or ureter was explored first, while the vena cava was located first for those on their left flank; these were considered anatomical landmarks. The renal pedicle was separated, followed by the connective tissue surrounding the renal pedicle sheath and its blood vessels. Approximately 2 - 3 cm of the renal arteries were freed. Three Hem-o-lok (vascular) clips were distributed on the renal artery side by side; the end of any one of the blood vessels near the heart was called the proximal end, while the end distant from the heart was the distal end. If the three Hem-o-loks were numbered 1, 2, and 3,

Table 1. Comparison of the Characteristics of LRN and LPN

Group	Male, No. %	Age, y	Diameter \leq 3 cm	Diameter $>$ 3 cm	Upper kidney	Middle Kidney	Lower Kidney
LRN (n = 25)	17 (68)	52.4	13	12	9	11	4
LPN (n = 20)	13 (65)	49.2	11	9	8	10	2

the renal artery was severed between the second and third Hem-o-lok. The renal artery was cut, and the renal vein on the deep surface and its branch were freed. This same method used for the renal arteries was also employed for the occlusion of the renal veins with three Hem-o-loks. The peri-renal fascia was then separated, and the anterior surface of the kidney was freed. The inside of the upper pole of the peri-renal fascia was cut with an ultrasonic knife for separation up to the renal pedicle. Next, the ureter was detached up to the level of the iliac vessels, followed by disarticulation with two titanium clips. Postoperative recurrence and metastasis of small RCC were monitored using periodic reviews of the serum creatinine and blood urea levels as well as ultrasonographic and CT findings.

3.3. Observation Indicators

The operative time, amount of intraoperative blood loss, length of hospital stay, preoperative creatinine levels, and postoperative creatinine levels after 24 hours in the two groups were recorded. The survival rates at the 1-, 2-, and 3-year postoperative follow-up visits were also calculated.

3.4. Statistical Analysis

The Statistical package for the social sciences (SPSS) version 15.0 was used to establish a database. The clinical data of patients with small RCCs were analyzed using the t-test and chi-squared test. A P-value < 0.05 indicated a statistically significant difference.

4. Results

Tumor sizes ranged from 2.1 - 4.0 cm, with a mean size of 3.0 ± 0.8 cm. Of the 45 tumors, 17 were located in the upper pole of the kidney, 21 were in the middle of the kidney, and 7 were found in the lower pole of the kidney. With respect to carcinoma type, 31 tumors were confirmed as suprarenal epithelioma, while 14 cases were identified as granular cell carcinoma. In all patients, contralateral renal function was normal, with no history of disease in either the kidney or ureter.

The differences in operative time, amount of blood loss, and length of hospital stay were compared between the groups and had no statistical significance according to

a t test (Table 2). As shown in Table 3, the differences in the preoperative and postoperative creatinine levels after 24 hours were compared between the two groups and also had no statistical significance based upon the chi-square test. The 1-, 2-, and 3-year survival rates were contrasted between the two groups and revealed no statistical significance by test (Table 4).

5. Discussion

Small RCC is a common urological tumor. Open surgery, laparoscopic surgery, and other techniques are conventionally used to treat small RCC. Open surgery tends to be associated with a higher degree of trauma, more complications, and a less-than-ideal postoperative recovery compared to laparoscopic methods. With the advancement of laparoscopic techniques and instruments, there are now just as many indications for LRN as there are for traditional open surgery. During the early development of the LRN procedure, a T1NoMo stage tumor was an absolute indication for LRN. However, the increased experience of laparoscopic surgeons allowed the LRN indications to expand to include T2NoMo and some T3aNoMo tumors (15). As a result, tumor size is no longer a decisive factor for different surgical options.

As long as renal tumors are confined within the renal fascia, LRN is usually feasible regardless of size (16-18). The efficacy of this procedure is similar to that of open surgery, and no statistically significant differences in the 5-year survival rates between patients treated by the two methods have been reported (19). Laparoscopic surgery prevents and reduces damage to vital organs by establishing a pneumoperitoneum; a peritoneal incision after surgery is not required. Laparoscopic surgery allows the retroperitoneal space to be expanded, reducing interference by abdominal organs and avoiding contamination of the abdominal cavity. It also prevents adhesions and provides some bowel protection. Retroperitoneal laparoscopic surgery can accurately identify and allow access to the surrounding kidney avascular plane to improve operative efficiency and reduce intraoperative blood loss. After establishing the retroperitoneal operating space, the lateroconal fascia is first freed from within the extraperitoneal fat. Next, the loose network organization to the middle of the spine is

Table 2. Comparisons of Operative Time, Intraoperative Blood Loss, and Length of Hospital Stay for Patients With Small Renal Cell Carcinoma in the Two Groups

Groups	Cases	Operative Time, minute	Intraoperative Blood Loss, mL	Hospital Stay length, d
Group A	25	100.6 ± 35.7	135.7 ± 20.5	17.5 ± 3.5
Group B	20	95.6 ± 20.2	125.8 ± 19.6	16.5 ± 2.5
t-Value		0.49	1.44	0.94
P-Value		> 0.05	> 0.05	> 0.05

Table 3. Comparisons of Preoperative Creatinine and Postoperative 24-Hour Creatinine Levels for Patients With Small Renal Cell Carcinoma in Both Groups

Group	Cases	Preoperative Creatinine, $\mu\text{mol/L}$	Postoperative 24-Hour Creatinine, $\mu\text{mol/L}$
Group A	25	82.5 ± 15.7	135.7 ± 20.5
Group B	20	85.6 ± 16.2	125.8 ± 20.6
t-Value		0.57	1.41
P-Value		> 0.05	> 0.05

opened, which allows the exploration of the renal pedicle in front of the psoas muscle.

Retroperitoneal LRN involves clamping the freed renal artery with a Hem-o-lok ligation clip to minimize the renal blood supply as much as possible and therefore reduce blood loss. The kidney is hung up for observation when the avascular zone between the renal front fascia layer and the integration fascia are separated so that the kidney can be clearly observed. The descending colon, pancreatic tail, and portion of the spleen in the renal clearance on the left anterior fascia can be freed inward to easily view and access the front of the left renal pedicle and the abdominal aorta. The ascending colon, duodenum, pancreatic head, and common bile duct can then be freed on the right side. The front of the right renal pedicle and the inferior vena cava are next separated from the kidneys, thus completing the transection of the kidneys and the surrounding tissues. LRN focuses on arranging the renal vessels before freeing them to identify the separated anatomical structures, avoid deep insertion of the ultrasonic knife, prevent peritoneum and renal fascia damage, and reduce or eliminate blood metastasis and local planting of tumor cells (20, 21).

In our study, LRN allowed the surgeon to completely free the anterior or posterior kidneys and the upper or lower poles within the renal adipose capsule, separate and expose the renal arteries, clip the freed renal artery with no damage, then partially resect and suture the tumor and the surrounding kidney tissues. The purpose of completely freeing the kidney before resecting the tumor was to allow the kidney to move freely, which results in reduced difficul-

ties in stitching and also shortens the warm ischemia time. Recent studies have confirmed that damage to the kidneys cannot be completely reversed if the warm ischemia time is > 30 minutes during LRN (22). If the estimated intraoperative renal ischemia time might exceed 30 minutes, cold treatment should be administered on the kidney's surface. Previous studies have shown that the metabolic activity of the kidney is significantly reduced at a temperature of 5 - 20°C (23, 24). At temperatures from 10 - 25°C, the metabolic activity of the kidney significantly decreases; the kidneys can tolerate a renal ischemia time of up to 3 hours without permanent damage. With the technological development and introduction of laparoscopic and robot-assisted laparoscopic techniques in recent years, the impact of the intraoperative mean warm ischemia time has been significantly reduced with the introduction of clinical applications, such as segmental renal artery occlusion (25), early release of the renal artery occlusion clamp (26), low perfusion of the renal artery (27, 28), and clamping only the tumor vessels (29). As a result, postoperative renal function has vastly and significantly improved over that achieved in early laparoscopic surgical techniques. In 2010, the EAU guidelines (30) recommended partial nephrectomy as the gold standard for the treatment of T1 RCC and stressed the importance of performing this procedure using laparoscopic techniques. These guidelines stated that complete resection of the tumor negates the influence of the gap between the resection margin and the pseudocapsule on the local recurrence of the tumor.

The clinical data of 45 patients with small RCC who were admitted to our hospital's Urology Department were analyzed, and the patients were divided into two treatment groups: Group A (retroperitoneal LPN, 25 cases) and Group B (retroperitoneal LRN, 20 cases). Our results indicated that the operative time, amount of intraoperative blood loss, length of hospital stay, preoperative creatinine levels, postoperative creatinine levels after 24 hours, and 1-, 2-, and 3-year survival rates were not significantly different between the groups, suggesting that there were no important distinctions between retroperitoneal LPN and LRN in terms of their survival rates and short-term postoperative complications. However, the efficacy of retroperi-

Table 4. Comparisons of 1-, 2-, and 3-Year Survival Rates for Patients With Small Renal Cell Carcinoma in the Two Groups

Group	Cases	1-Year Survival Rate (Cases)	2-Year Survival Rate (Cases)	3-Year Survival Rate (Cases)
Group A	25	100% (25)	92% (23)	90% (22)
Group B	20	100% (20)	90% (18)	86.7% (18)
X ² Value		0	0.09	0.07
P-Value		> 0.05	> 0.05	> 0.05

toneal LPN was greater than that of LRN. Partial nephrectomy can maximize the retention of normal renal tissues, which has obvious advantages for both contralateral kidneys with lesions and solitary kidneys, and can be used as the preferred method in clinical practice.

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Footnotes

Authors' Contribution: Study concept and design, Shuyong Yu; analysis and interpretation of the data, Hongfeng Shen, Ruisha Tu, Wei Li, Geng He, and Wei Huang; drafting of the manuscript, Hongfeng Shen and Ruisha Tu; statistical analysis, Zhenchang Qin and Chongfeng Wang; critical revision of the manuscript for important intellectual content, administrative, technical, and material support, and study supervision, Shuyong Yu.

Conflict of Interest: All authors declare that they have no conflicts of interest regarding this paper.

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