Int J Clin Exp Med 2017;10(7):10983-10988
www.ijcem.com /ISSN:1940-5901/IJCEM0041963

Original Article

Laparoscopic radiofrequency ablation assisted partial nephrectomy versus laparoscopic partial nephrectomy for renal angiomyolipomas: experience from a medical center

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Received October 15, 2016; Accepted March 18, 2017; Epub July 15, 2017; Published July 30, 2017

Abstract: Purpose: This study aimed to compare the functional outcome, safety and efficacy of laparoscopic radiofrequency ablation assisted partial nephrectomy (LRAPN) versus laparoscopic partial nephrectomy (LPN) for renal angiomyolipoma (AML). Methods: 103 patients treated with LRAPN or LPN were recruited into present study, and the perioperative characteristics were compared. Results: All operations were performed successfully without massive hemorrhage or switch into open surgery. The baseline characteristics were comparable between two groups. In LRAPN group and LPN group, the median tumor size was 6.35 cm and 6.63 cm, mean operative time (OT) was 88.7 min and 100 min ($P<0.05$), mean warm ischemia time (WIT) was 0 min and 18.7 min ($P<0.05$); mean estimated blood loss (EBL) was 105.6 ml and 134 ml ($P<0.05$), mean retroperitoneal drainage lasted 3 days and 3.5 days, and mean postoperative hospital stay was 5.12 days and 5.6 days, respectively. The postoperative change in eGFR was significantly smaller in LRAPN group than in LPN group ($P<0.05$). No recurrence occurred in these patients during a median follow up duration of 43.6 months. Conclusion: LRAPN is an alternative, safe and feasible approach for the treatment of AML and may achieve better kidney function, less blood loss and shorter operative time as compared to LPN.

Keywords: Laparoscopic radiofrequency ablation assisted partial nephrectomy, angiomyolipoma, laparoscopic partial nephrectomy

Introduction

Renal angiomyolipoma (AML) is the most common benign renal neoplasm, and composed of variable amounts of muscle, fat and vascular tissues. The incidence of AML has been reported to be 0.1% in males and 0.2% in females of a population without tuberous sclerosis complex (TSC) and be 20%-30% in TSC patients [1]. The diagnosis of AML is usually dependent on computerized tomography (CT) which may display the appearance of adipose tissues with negative density (-20 Hounsfield units or less) in the lesion. However, adipose tissues can not be identified in 14% of AMLs by CT scan [2, 3]. With the growth of AMLs, they usually become more vascular and may develop tortuous vessels and aneurysms that are easy to rupture. The main morbidity of AMLs is spontaneous life-threatening hemorrhage, which can be retroperitoneal or present with visible hematuria [4]. Though AMLs are often symptomatic and identified incidentally on imaging, they may cause flank pain, gross hematuria and hypotension as a result of retroperitoneal hemorrhage, anorexia, nausea and vomiting. At presentation, 14% of patients with sporadic renal AML and 44% of patients with TSC renal AMLs have hemorrhage [5]. AMLs larger than 4 cm are required treatment to reduce the risk of hemorrhage or alleviate their symptoms such as pain [6].

Current treatment options include partial nephrectomy (PN), selective arterial embolization (SAE) and pharmacological therapies (such as sirolimus and everolimus). Radiofrequency ablation (RFA) has effective hemostatic effect and is becoming a novel alternative treatment for RCC [7] and AMLs [5, 8]. However, few studies have been conducted to investigate the outcome of laparoscopic radiofrequency ablation assisted laparoscopic partial nephrectomy (LRAPN). To the best of our knowledge, this was the first study comparing the outcomes of LRAPN versus LPN in AML patients. This article aimed to introduce LRAPN as a novel therapeutic method of AML.

Patients and methods

Patients

This study was approved by the Institutional Review Board. A total of 103 consecutive patients with AML who received surgical treatment for renal AMLs in our institution between February 2008 and December 2014 were retrospectively assessed. Written informed consent was obtained before study. Among them, LRAPN was performed in 41 patients (15 men and 26 women) with a median age of 49 years (range: 26-75 years) and LPN in 62 patients (25 men and 37 women) with a median age of 51.3 years (range: 25-78 years) by two experienced surgeons (YHC and JZ). All patients were preoperatively evaluated by urine analysis, detection of serum creatinine (Scr), renal B-ultrasonography and computed tomography (CT) and/or magnetic resonance imaging (MRI).

Patients with bilateral lesions or concomitant TSC were excluded from this study. Patients' demographics, intra-operative parameters and post-operative outcomes including the findings from follow up were recorded and retrospectively analyzed. Hypertension, diabetes and cardiovascular disease were defined as comorbidities potentially affecting the renal function.

Surgical treatment

In this study, LRAPN (n=41) and LPN (n=62) were employed for treatment of renal AMLs in our hospital in the same period. All of the 103 patients received surgery via a retroperitoneal approach. After induction of general anesthesia, patients were placed in the left or right lateral decubitus position at 90°. Laparoscopy was performed with a 3- or 4-trocar technique. In LRAPN group, a ureteral stent was placed for retrograde injection of methylene blue-saline mixture to assist the collection system closure in special patients. The renal artery was carefully dissected for unintended clamping if serious bleeding occurred. Then, the kidney was exposed and the tumors were localized. Intraoperative ultrasound was used to assess the depth of the lesion and its relation with major vessels. Thermal sensors were placed at the tumor periphery. Multiple biopsies were taken before RFA, and a Cool-Tip™ water-perfused ablation probe (Covidien Inc., Boulder, CO, USA) was inserted into the tumor afterward. The frequency, direction and depth of ablation probe depended on the base and depth of the tumor. After probe deployment, the cold circulation pump and the generator were started. Initial power was low and then increased with an increment of 10W, according to the manufacturer's instructions, and the final temperature was higher than 65°C. The output power was elevated to maintain the probe temperature at 90-100°C, which carbonized the needle track for hemostasis. After RFA, the tumor was collected with the electric scissor or ultrasound knife, and the tumor bed was carefully checked. A retroperitoneal drainage tube and urinary catheter were placed in all patients.

In LPN group, conventional LPN was performed in all the patients. After the construction of a retroperitoneal cavity, the paranephric fat was removed from the Gerota's fascia, which was subsequently opened and incised away from the tumor to facilitate the excision and suturing. The renal vessels were carefully separated, and the renal artery was completely clamped with laparoscopic bulldog clamps. After a transient occlusion, the AML lesion was sharply excised with cold scissors in an almost bloodless field, and the suction device usually accompanied the scissors to aid the separation from the normal kidney. Afterwards, hemostasis was achieved by suturing. Then, the vascular clamp was removed, and hemostasis was evaluated. Subsequently, the tumor was collected with an endobag, and a drainage tube was placed in the retroperitoneal cavity.

Data analysis

Demographic and intra-operative data were prospectively input into a computerized database. Postoperative data were collected by

Table 1. Baseline characteristics of patients in LRAPN group and LPN group

Parameters	LRAPN (n=41)	LPN (n=62)	*p* value
Gender			0.703
Female (%)	26 (63.4)	37 (59.7)	
Male (%)	15 (36.6)	25 (40.3)	
Age	49.0 ± 9.9	51.3 ± 12.2	0.231
BMI, kg/m^2	24.6 ± 1.5	24.9 ± 1.8	0.115
Tumor location			0.958
Right	15 (36.6)	23 (37.1)	
Left	26 (63.4)	39 (62.9)	
Tumor size (cm)	6.35 ± 0.97	6.63 ± 1.2	0.128
RENAL score	6 (4-10)	6.4 (4-10)	0.428
No. ASA score			
1-2	38	60	
3-4	3	2	

hospital visit or telephone. The Scr and eGFR were detected before and after surgery and at 6-month follow-up. Descriptive data are presented as numbers and percentages, and continuous data as means ± standard deviation (SD). The descriptive and continuous variables were compared using χ^2 test or independent t test. Statistical analysis was performed with SPSS version 17.0 (Statistical Package for Social Sciences, USA), and a value of $P<0.05$ was considered statistically significant.

Results

Patients' characteristics

All operations were performed successfully without switch to open surgery. The detailed patients' characteristics are show in **Table 1**. No significant differences were observed in these characteristics between two groups. One patient in LRAPN group and two patients in LPN group received intra-operative blood transfusion. Preoperative CT showed the mean tumor size was 6.35 ± 0.97 cm in LRAPN group and 6.63 ± 1.2 cm in LPN group ($P=0.128$).

Surgical outcomes

Intra-operative variables and postoperative outcomes are shown in **Table 2**. In LRAPN group, the mean operative time (OT) was 100.7 ± 9.8 min, and only one patient required 5-min warm ischemia time (WIT) for renal artery clamping due to uncontrollable bleeding. The mean estimated blood loss (EBL) was 105.6 ± 51.3 ml, the mean retroperitoneal drainage lasted for 3.0 ± 0.6 days, and the mean postoperative hospital stay was 5.1 ± 1.0 days. In LPN group, the mean OT was 115 ± 19 min, the mean WIT was 22 ± 3.3 min, the mean EBL was 134 ± 86.2 ml, the mean retroperitoneal drainage lasted for 3.5 ± 0.8 days and the mean postoperative hospital stay was 5.6 ± 1.2 days. Significant differences were observed in the OT, WIT and EBL between both groups ($P<0.05$).

The mean preoperative eGFR was 97.5 ± 18.1 ml/min/1.73 m^2 in LRAPN group and 98.6 ± 19.0 ml/min/1.73 m^2 in LPN group, and no significant difference was observed between them. However, the post-operative eGFR and eGFR at 6month follow-up were 88.7 ± 15.8 and 91.3 ± 16.0 ml/min/1.73 m^2, respectively in LRAPN group, which were significantly higher than in LPN group (72.8 ± 25.0 and 74.4 ± 24.5 ml/min/1.73 m^2, $P<0.05$) (**Table 3**).

Complications

Intraoperative bleeding (Clavien II) was found in 1 patient and urine leakage (Clavien I) in 2 patients of LRAPN group; while two patients developed intraoperative bleeding (Clavien II), two had urine leakage (Clavien I) and one had transient hematuria (Clavien I) in LPN group. Significant differences were not observed in these complications between two groups ($P>0.05$). None had radiographic evidence of recurrent AML at a median follow-up duration of 43.6 months (range: 6-84 months) in both groups.

Discussion

Renal AML is a benign renal tumor accounting for 3% of all kidney tumors with a female dominant [6]. The treatments for AMLs are always dependent on the tumor size and symptoms. Asymptomatic AMLs sized <4 cm only require close monitoring, and semiannual tumor imaging is recommended, while interventions should be considered for symptomatic AML sized <4 cm, AML sized >4 cm or lesions with local tissue or vascular involvement, or suspected malignancy after imaging [6, 9, 10]. Current treatment options include PN and RAE. RFA is an alternative treatment for AML because of its hemostatic effect [5].

Table 2. Perioperative characteristics of patients in LRAPN group and LPN group

Parameters	LRAPN (n=41)	LPN (n=62)	*p* value
Operating time (min)	100.7 ± 9.8	115 ± 19.1	0.004
Warm ischemia time (min)	0	22 ± 3.3	0.000
Intraoperative Transfusions	1 (36.6)	2 (40.3)	
Estimated blood loss (ml)	105.6 ± 51.3	134.0 ± 86.2	0.023
Drainage (days)	3.0 ± 0.6	3.5 ± 0.8	0.104
Hospitalization (days)	5.12 ± 1.0	5.6 ± 1.2	0.161
Intra-operative Complications			0.816
Hemorrhage	1 (2.4%)	2 (3.2%)	
Postoperative Complications			0.992
Urine leakage	2 (4.9%)	2 (3.2%)	
Hematuria	0	1 (1.6%)	

Table 3. eGFR before and after surgery and at 6-month follow up in patients of LRAPN group and LPN group

	eGFR		
	Pre-operative	Post-operative	Follow-up at 6-month
LRAPN group	97.5 ± 18.1	88.7 ± 15.8	91.3 ± 16.0
LPN group	98.6 ± 19.0	72.8 ± 25.0	74.4 ± 24.5
P	0.882	0.019	0.043

PN for sporadic renal AML is able to preserve the kidney function and has acceptable complication and low local recurrence rate [11, 12], and may improve kidney function when compared with RN in case of small renal AML [13]. In this study, we summarized our experience in the treatment of renal AML larger than 4 cm with LRAPN and LPN. To our knowledge, our study represents the largest series with the longest follow-up duration reported to date. The median size of AML at LRAPN was 6.35 cm (range: 4-10 cm), which was larger than the previously reported [5, 8, 14]. During the follow-up period, none developed symptom recurrence or required dialysis.

The technique combining laparoscopic radiofrequency coagulation (RF) and PN (RF-LPN) for the treatment of renal tumor was firstly reported by Jacomides et al [15]. The advantages of this technique are that it allows not only tumor excision without ischemia time, but may eliminate the need for laparoscopic suturing and decrease the blood loss [7]. In our cohort, when LRAPN was performed for the treatment of renal AML, the findings were comparable to previously reported: the median OT, WIT and EBL in LRAPN group decreased significantly as compared to conventional LPN group (P=0.004, 0.000 and 0.023, respectively).

There was a significant decline in kidney function after RN as compared to PN [16]. The ischemia time of LPN within 30 min was generally accepted, but a recent study indicated that every minute of ischemia might affect the kidney function [17]. In our cohort, the mean WIT was 0 min in LRAPN group (one patient had 5-min WIT due to renal artery clamping for uncontrollable bleeding) which was much significantly shorter than in conventional LPN group (*P*= 0.000). Our previous study showed that laparoscopic radio frequency ablation assisted tumor dissection was not only associated with a smaller decrease in GFR of the affected kidney as shown by radionuclide scintigraphy at 3 months and 12 months, but was able to better preserve kidney function as compared to LPN [18], which was also confirmed by the present study. During the follow-up period, none required permanent or transient dialysis.

In the present series, 41 patients with renal AMLs were successfully treated with LRAPN. The incidence of procedure-specific complications was 7.3% (3/41), only one received renal artery clamping due to uncontrollable bleeding, and two had transient urine leakage. The incidence of complications in LRAPN group was similar to that in LPN group. Although renal arterial embolization has been used more frequently than PN in the treatment of renal AML and it may reduce the risk of perioperative hemorrhage, it was not recommended to patients in our series for its high recurrence rate and high incidence of complications unless the patients developed serious bleeding before surgery [19, 20].

Overall, our results indicate that LRAPN is safe and effective for the treatment of renal AML. However, the present study was retrospective, and patients were not randomly assigned. Thus, further prospective studies are required to confirm our results and provide more evidence on the role and importance of LRAPN in the treatment of renal AMLs.

Conclusion

Compared with traditional LPN, LRAPN was demonstrated to have advantages in protecting renal function. Besides, there were also significant differences in several perioperative indicators, including operation time, warm ischemia time, and safety. LRAPN offers favorable perioperative outcomes and survival rate, and is associated with low recurrence rate. Our results support LRAPN as an alternative, safe and feasible approach for the treatment of renal AMLs.

Acknowledgements

This study was supported by Grant Number 81472378 from National Natural Science Foundation of China and PYZY16-006 from the Incubating Program of Ren Ji Hospital, Shanghai, China.

Disclosure of conflict of interest

None.

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