Single-Port Sutureless Partial Nephrectomy for Small Renal Cancer

Ching-Chia Li

Kaohsiung Medical University Chung Ho Memorial Hospital

Tsu-Ming Chien

Kaohsiung Medical University Chung Ho Memorial Hospital

Hsin-Chih Yeh

Kaohsiung Medical University College of Medicine

Hsiang-Ying Lee

Kaohsiung Medical University Chung Ho Memorial Hospital

Hung-Lung Ke

Kaohsiung Medical University Chung Ho Memorial Hospital

Sheng-Chen Wen

Kaohsiung Medical University Chung Ho Memorial Hospital

Wei-Che Chang

Kaohsiung Medical University Chung Ho Memorial Hospital

Yung-Shun Juan

Kaohsiung Medical University Chung Ho Memorial Hospital

Yii-Her Chou

Kaohsiung Medical University Chung Ho Memorial Hospital

Wen-Jeng Wu (✉ slaochain@gmail.com)

Kaohsiung Medical University Chung Ho Memorial Hospital

Research

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Abstract

Background: Laparoscopic single-port (LESS) sutureless partial nephrectomy (PN) is a technically demanding procedure. Here we shared our experience to reduce the warm ischemia time and shorten the learning curve in performing LESS sutureless PN.

Materials and methods: Between 2015 and 2018, custom made LESS sutureless PN was performed in 33 patients with small renal cancer. Preoperative, intra-operative and postoperative variables were recorded. Renal function was evaluated by estimated glomerular filtration rate (eGFR) pre- and postoperatively.

Results: The average warm ischemia time and the operation time were 11.8 ± 3.9 min and 167.9 ± 37.5 min, respectively. Only 2 patients suffered from massive urinary leakage (>200 mL/day) from the Jackson Pratt drainage tube, but the leakage spontaneously decreased within 7 days after the surgery. eGFR and serum hemoglobin were not found to be significantly different pre- and postoperatively. All tumors were removed without positive surgical margin. All patients were alive without recurrent tumors at mean postoperative follow-up of 16.5 ± 6.4 months.

Conclusions: LESS sutureless PN is a feasible surgical method for most patients with small renal cancer with excellent cosmetic results, shorter learning curve without affecting oncological results.

Introduction

In 2009, the American Urological Association (AUA) [1] recommended partial nephrectomy (PN) as the reference standard treatment for most clinical T1 renal masses, even in individuals with a normal contralateral kidney, due to its similar efficacy to radical nephrectomy while also preserving kidney tissue. Since that time, a review of nephrectomy records submitted as part of the American Board of Urology surgeon certification/recertification process revealed that the use of PN has increased from 25% to 39% of all nephrectomies [2]. PN preserves kidney function better and limits long-term development of metabolic as well as cardiovascular disorders.

The European Association of Urology considers PN the treatment of choice for T1b renal cell carcinoma (RCC) [3].

Open PN remains the gold standard procedure in most patients with localized renal cancer. Though no randomized controlled studies have compared the safety and oncological outcomes in terms of renal function and surgical margins, the steep learning curve with laparoscopic partial nephrectomy (LPN) remains a concern [4]. LPN is a technically demanding procedure, even under robotic assistance. Several important challenges, such as preventing perioperative bleeding, reaching hyperthermia after renal artery clamping, reducing warm ischemia time, and performing laparoscopic intracorporeal suturing, must be met during the operation. Despite the ability to achieve renal hyperthermia by delivering cold saline into the renal pelvis, the cooling effect is not qualified during laparoscopic surgery. Gill et al. [5] reported a novel method using ice slush around the kidney; however, it is difficult to replicate during the laparoscopic

procedure. Because it is difficult to achieve renal hypothermia during LPN, it is important to reduce the warm ischemia time, which is understood to correlate with subsequent return of renal function [6]. Traditional clamping procedures require a significant warm ischemia time during the suturing process. Hemostatic suturing plays a vitally important role, even in the current era of early unclamping [7], selective clamping [8], and unclamping techniques [9-11].

We previously shared our “pressure-cooker” method of performing LPN without intracorporeal suturing [12]. In the current study, we present our technique of laparoendoscopic single-site (LESS) sutureless PN. Our method is shown to reduce the warm ischemia time, and we believe this technique will shorten the learning curve in performing LPN for surgeons who lack experience in intracorporeal suturing.

Materials And Methods

Patients

A total of 33 patients underwent LPN between March 2015 and May 2018 at the Kaohsiung Medical University and Kaohsiung Municipal Ta-Tung Hospital. All patients were informed of the potential complications and risks of the novel techniques. The study was conducted according to the principles of the Declaration of Helsinki and supervised by the local Ethics Committee of the Kaohsiung Medical University Hospital. Written informed consent was obtained from all patients prior to their enrollment in the study. Patients with localized renal parenchymal tumor (stage T1N0M0) without endophytic properties or tumor located <4 mm from the collecting system were included. We excluded patients with suspected lymph node or distant metastasis. We quantified the anatomical characteristics of the renal masses using the R.E.N.A.L. nephrometry score[13]. In total, 33 patients undergoing LPN were enrolled in the study.

Approach

We previously published an article reporting our basic sutureless laparoscopic PN method [10]. Patients were placed in flank position with the lesion site elevated to 90 degrees. The surgeon and assistant stood facing the patient’s back. The length of the skin incision was approximately 2.5–3.5 cm according to the tumor diameter. The port incision was made just below the 12th rib in the posterior axillary line. All procedures were performed using the retroperitoneal approach. A balloon dilator was used to create the retroperitoneal space, which was entered via the exposed thoracolumbar fascia, irrespective of their location. We used the LagiPort (Lagis, Inc., Taichung, Taiwan), a multi-instrument access port designed especially for LESS PN (Figure 1). Gerota’s fascia was dissected anteriorly and posteriorly. Next, an incision was made to mobilize the kidney from the perirenal fat, revealing the renal artery and primary tumor. If the tumor margin is not clear, intraoperative ultrasonography is used to better visualize the tumor margin. A fat pad from the perirenal space is prepared and should be located as far away from the tumor as possible.

Tumor excision: The “pressure cooker” method

In the selective renal artery non-clamping patients, a harmonic scalpel was used to remove the tumor, leaving a 0.5 to 1 cm safety margin. In the renal clamping group, the tumor was excised using laparoscopic scissors with bulldog clamps. Vascular disruption with excision was extensively fulgurated. For this procedure, we use monopolar coagulation via laparoscopic scissors to seal off the cross-section of renal calyx or pelvis if any collecting system disruptions are noted. After tumor removal, a hemostatic matrix (FloSeal; Baxter Healthcare, Zurich, Switzerland) is placed into the renal cavity, and a fibrin sealant (Tisseel; Baxter) is injected to cover the entire hemostatic matrix and the surrounding normal renal tissue. At the end of the surgery, the fat pad is placed to cover all of the areas coated with fibrin sealant, and the bulldog clamp is detached. The fat pad covering should be accomplished within 20 seconds to prevent solidifying of the fibrin sealant. The fat pad will adhere to the periphery of the incision field, and the hemostatic matrix will be “cooked” and closed off underneath. After the gelatin matrix and thrombin component are combined, the hemostatic matrix will expand around 20% of the volume upon contact with blood or urine. This reaction will occur soon after removing the bulldog clamp. The hemostatic matrix is engorged within the airtight space covered by the fat pad just like a “pressure cooker,” causing extra external pressure to compress the postoperative bleeding (Figure 2). The tumor specimen can be removed directly through the port using a laparoscopic grasper. We placed a drainage tube in 20 patients, and we do not leave a drainage tube in small and exophytic tumors.

Results

Study population

The preoperative data are shown in Table 1. The average patient age was 59.7 ± 11.1 years (range: 36.0–77.0). Seventeen patients (51.1%) were male. The patient population was generally non-obese with a mean body mass index of 26.8 ± 3.2 (range: 21.9–38.1). Preoperative American Society of Anesthesiologists and Eastern Cooperative Oncology Group scores were 1.2 ± 0.4 (range: 1.0–2.0) and 0.3 ± 0.5 (range: 0–1), respectively. Eighteen patients had a left-sided renal mass. The average tumor size was 2.7 ± 1.1 cm (range: 1.5–5.0 cm). The mean R.E.N.A.L. nephrometry score [11] was 5.7 ± 1.5 (range: 4.0–9.0).

Surgical outcomes

The average operation time was 167.9 ± 37.5 minutes (range: 100–250 minutes). To achieve renal hilar control, the clampless method was used in 6 patients due to tumors in exophytic locations or the majority of tumors had a distinct fibrotic capsule. Bulldog clamps were used for temporary renal artery occlusion in the remaining 27 patients. The average warm ischemia time was 11.8 ± 3.9 minutes (range: 8–26 minutes). The renal clamping strategy was made according to the surgeon, preoperative imaging, intraoperative findings, and intraoperative ultrasound. Mean estimated blood loss was 104.0 ± 105.8 mL (range: 10.0–430.0 mL). Only 1 patient required a perioperative blood transfusion due to large tumor burden. Conversion to conventional laparoscopy or open surgery was not necessary (Table 2). We do not perform the renal cooling technique. After the operation, the renal tumor was removed from the LESS

wound. In total, 5 patients had obvious collecting system disruption during the procedures. We did not perform reconstruction of the collecting system. Only 2 patients suffered from massive urinary leakage (>200 mL/day) from the Jackson Pratt drainage tube (Table 3), but the leakage spontaneously decreased within 7 days after the surgery without requiring additional surgery. The mean length of hospital stay was 5.6 ± 1.5 days.

Oncological outcomes

The pathological results revealed clear cell RCC in 18 patients (54.5%; pT1a in 14 and pT1b in 4), angiomyolipoma in 8 (24.2%), oncocytoma in 3 (9.1%), papillary RCC in 3 (9.1%; all pT1a), and chromophobe RCC in 1 (3.0%; pT1a) patient (Table 3). One oncocytoma and 1 angiomyolipoma patient with positive surgical margins received close follow-up ultrasound and computed tomography scans. Neither the residual tumor nor recurrence were observed on imaging study after 26 months of follow-up. All patients were alive without recurrent tumors at mean postoperative follow-up of 16.5 ± 6.4 months (range: 5.0–27.0 months).

Renal function and haemoglobin level

The preoperative and postoperative estimated glomerular filtration rate (eGFR) was 76.6 ± 22.4 and 69.6 ± 24.3 , respectively. There was no significant decrease in eGFR level ($p = 0.228$). A marginal decrease in haemoglobin level was observed (preoperative vs postoperative; 13.9 ± 1.3 vs 13.3 ± 1.3 ; $p = 0.064$) but did not reach statistical significance (Table 2, 3). No significant difference was found between preoperative and postoperative eGFR and haemoglobin level. Notably, the average skin incision was 2.8 ± 1.1 cm with excellent cosmetic outcomes.

Discussion

PN was initially reported in 1993, and McDougall et al. [14] first reported a wedge resection technique for removal of small, low-stage renal masses via LPN. Since then, LPN has been increasingly used due to refined laparoscopic suturing techniques and the availability of hemosealant substances. Although no randomized study has compared safety and oncological outcomes between LPN and the open technique, the main concern with LPN has always been the steep learning curve [4]. Stifelman et al. [15] reported the first robotic-assisted (RA) PN in 2005, demonstrating that this approach allowed for accurate lesion resection and easier reconstruction of the renal defect. A recent U.S. study [16] using the Nationwide Inpatient Sample database determined practice patterns and perioperative outcomes of open and minimally invasive PN, revealing that RAPN is currently performed more commonly than is LPN. Conversely, LPN is more widely used (69.8%) in minimally invasive procedures compared to RAPN (30.2%) in the U.K [17]. A recent meta-analysis [18] combining 4919 patients from 25 studies (RAPN in 2681 and LPN in 2238) revealed no significant differences between the 2 groups in terms of age, sex, laterality, and final malignant pathology; however, the tumor was larger, with higher mean R.E.N.A.L. nephrometry scores in the former group. Patients treated with RAPN had a decreased likelihood of conversion to open surgery compared to those treated with LPN. RAPN also was associated with reduced

complications, fewer positive margins, and shorter warm ischemia time [18]. Potential disadvantages of RAPN included cost, training, setup time, and lack of tactile sensation or haptics. The robotic procedure had a lower odds of advantages compared to laparoscopic PN except for in the category of hospital charges. We think that LPN still has competitive value in patients with small renal tumors. The major concern with LPN is the learning curve. Our technique provides a feasible method without the use of intracorporeal suturing and achieves excellent functional outcomes without affecting oncological results. At our institution, we started performing laparoscopic PN in 2003 and LESS PN in 2013. We have also performed RAPN for large renal tumors since 2015. In recent years, LESS PN has been our standard operation for patients with small renal masses. For those with larger tumors, open and RAPN are 2 of our most utilized surgical procedures.

Our study identified 5 patients with obvious disruption of the collecting system. We did not perform traditional suture repair of the collecting system. [Ploussard et al. \[19\]](#) showed that even after deep one-third PN, the combinations of FloSeal and Tisseel appeared to sufficiently control the major medullary vascular injuries and replace the conventional deep medullary sutures without compromising operative outcomes in a pig model. We previously described our methods using combinations of hemostatic agents with a fat pad around the outer layer of the kidney. The fat pad encapsulated the hemostatic agents within the tumor-excised cavity, supplementing structural support of the expanding and swelling action of FloSeal after it interacts with blood or urine from within. The extra external pressure provided by the fat pad acts in theory like a “pressure cooker” in preventing postoperative bleeding. The suture procedure may occlude unnecessary vessels at the suture site, leading to areas of kidney necrosis in the region. By decreasing the risk of unnecessary segmental vessel occlusion, the potential advantages may be noted during functional and vascular follow-up examinations.

The most important factor in preserving renal function during PN is the percent of nephron mass preserved [6, 20-13]. In our series, one of our main findings relates to nephron mass preservation, which is of primary importance for functional recovery, consistent with reports from other studies that eGFR of small renal cancer was not significantly different pre- and postoperatively [10-11]. Traditionally, PN relies on clamping of the main artery, with ischemia time considered to correlate with postoperative renal function. Gill et al. [5] shared a novel technique of laparoscopic renal hypothermia with intracorporeal ice slush during PN. A recent report also demonstrated superior renal functional outcomes using a cold ischemia technique with statistical significance from the third postoperative month [24]. Dong et al. [25] also demonstrated that functional recovery from clamped PN is most reliable using hypothermia. However, this cooling procedure was not easy to replicate during laparoscopic surgery; therefore, it is important to reduce the warm ischemia time. A threshold may exist after the damage from ischemia begins. Thompson et al. [6] demonstrated that every minute is important, and 25 minutes was considered a safe threshold in patients with a solitary kidney. Lane et al. [23] evaluated early and late renal functional outcomes in 1,132 patients with 2 functioning kidneys, showing that a warm ischemia time of <20 minutes is not associated with clinically relevant functional loss compared to that of alternative techniques. Gill et al. [9] was the first to describe a technique of “zero ischemia,” which focused special attention on selective branch microdissection of renal vessels in the renal sinus; transient,

pharmacologically induced blood pressure reduction timed to coincide precisely with excision of the deep part of the tumor; laparoscopic ultrasound to score the proposed resection margin; and clip ligation of any specific tertiary or quaternary renal artery branches supplying the tumor. The effort to minimize ischemia is accompanied by increased blood loss during the procedure. The potential impact on the surgical margin may be influenced by the lack of a clear operative field, which may bring surgical challenges for inexperienced operators, especially in larger renal tumors [26]. A current review paper [26] argues that newer strategies focusing on selective clamping and non-clamping can make a complex surgery even more challenging, which may serve to limit the widespread use of PN for management of renal cancers. We believe that our technique should be used in single-site PN to improve not only the warm ischemia time but also the learning curve of surgeons. This technique can also be used in traditional open PN, LPN, and even RAPN for surgeons lacking experience in intracorporeal suturing. Our study has several limitations. First, this was not a randomized prospective analysis and was composed of a relatively small cohort. Most patients had characteristics of exophytic tumor. The use of this technique for endophytic tumor still needs to be explored. Our method allows surgeons to perform PN more easily and effectively with fewer complications compared to the open method.

In conclusion, LESS sutureless PN is a feasible surgical method for most patients with small renal cancer with excellent cosmetic results, shorter learning curve without affecting oncological results. Further prospective studies with longer follow-up are needed to observe the oncological safety of the technique.

List Of Abbreviations

AUA: American Urological Association

eGFR: estimated glomerular filtration rate

LESS: laparoscopic single-port

LPN: laparoscopic partial nephrectomy

PN: partial nephrectomy

RA: robotic-assisted

RCC: renal cell carcinoma

Declarations

Ethics approval and consent to participate

Written informed consent was provided by the patient and Ethical approval for the study was provided by the ethics committee of the Kaohsiung Medical University Hospital and Kaohsiung Municipal Ta-Tung Hospital.

Consent for publication

The study was conducted according to the principles of the Declaration of Helsinki and supervised by the local Ethics Committee of the Kaohsiung Medical University Hospital. Written informed consent was obtained from all patients prior to their enrollment in the study.

Availability of data and materials

The datasets used are available from the corresponding author on reasonable request.

Competing interests

Not applicable

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Authors' contributions

CCL and TMC conceived the study. TMC wrote the draft of the manuscript. HCY, HYL, HLK, SCW, WCC, YSJ and YHC collected the data. WJW revised the manuscript. All authors read and approved the final manuscript.

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References

1. Campbell SC, Novick AC, Belldegrun A et al. Guideline for management of the clinical T1 renal mass. *J Urol*. 2009; 182(4): 1271-1279.
2. Sorokin I, Feustel PJ, O'Malley RL. National Utilization of Partial Nephrectomy Pre- and Post- AUA Guidelines: Is This as Good as It Gets? *Clin Genitourin Cancer* 2017; 15(5): 591-597
3. Ljungberg B, Hanbury DC, Kuczyk MA et al. Renal cell carcinoma guideline. *Eur Urol* 2007; 51(6): 1502-1510
4. Springer C, Hoda MR, Fajkovic H et al. Laparoscopic vs open partial nephrectomy for T1 renal tumours: evaluation of long-term oncological and functional outcomes in 340 patients. *BJU Int* 2013; 111(2): 281-288
5. Gill IS, Abreu SC, Desai MM et al. Laparoscopic ice slush renal hypothermia for partial nephrectomy: the initial experience. *J Urol* 2003; 170(1): 52-56

6. Thompson RH, Lane BR, Lohse CM et al. Every minute counts when the renal hilum is clamped during partial nephrectomy. *Eur Urol*2010; 58(3): 340-345
7. Baumert H, Ballaro A, Shah N et al. Reducing warm ischaemia time during laparoscopic partial nephrectomy: a prospective comparison of two renal closure techniques. *Eur Urol*2007; 52(4): 1164-1169
8. Peyronnet B, Baumert H, Mathieu R et al. Early unclamping technique during robot-assisted laparoscopic partial nephrectomy can minimise warm ischaemia without increasing morbidity. *BJU Int*2014; 114(5): 741-747
9. Gill IS, Eisenberg MS, Aron M et al. "Zero ischemia" partial nephrectomy: novel laparoscopic and robotic technique. *Eur Urol*2011; 59(1): 128-134
10. Dell'Atti L, Scarcella S, Manno S, Polito M, Galosi AB. Approach for Renal Tumors With Low Nephrometry Score Through Unclamped Sutureless Laparoscopic Enucleation Technique: Functional and Oncologic Outcomes. *Clin Genitourin Cancer*2018; 16(6): e1251-e1256
11. Springer C, Veneziano D, Wimpissinger F, Inferrera A, Fornara P, Greco F. Clamplesslaparoendoscopic single-site partial nephrectomy for renal cancer with low PADUA score: technique and surgical outcomes. *BJU Int* 2013; 111(7): 1091-1098
12. Li CC, Yeh HC, Lee HY et al. Laparoscopic partial nephrectomy without intracorporeal suturing. *Surg Endosc*2016; 30(4): 1585-1591
13. Kutikov A, Uzzo RG. The R.E.N.A.L. nephrometry score: a comprehensive standardized system for quantitating renal tumor size, location and depth. *J Urol*2009; 182(3): 844-853
14. McDougall EM, Clayman RV, Anderson K. Laparoscopicwedge resection of a renal tumor: initial experience. *J Laparoendosc Surg* 1993; 3(6): 577-581
15. Stifelman MD , Caruso RP, Nieder AM, Taneja SS. Robot-assisted Laparoscopic Partial Nephrectomy. *J Soc Laparoendosc Surg* 2005; 9(1): 83-86
16. Ghani KR, Sukumar S, Sammon JD, Rogers CG, Trinh QD, Menon M. Practice patterns and outcomes of open and minimally invasive partial nephrectomy since the introduction of robotic partial nephrectomy: results from the nationwide inpatient sample. *J Urol*2014; 191(4): 907-912
17. Hadjipavlou M, Khan F, Fowler S, Joyce A, Keeley FX, Sriprasad S; BAUS Sections of Endourology and Oncology. Partialvs radical nephrectomy for T1 renal tumours: an analysis from the British Association of Urological Surgeons Nephrectomy *BJU Int* 2016; 117(1): 62-71
18. Leow JJ, Heah NH, Chang SL, Chong YL, Png KS. Outcomes of Robotic versus Laparoscopic PartialNephrectomy: an Updated Meta-Analysis of 4,919 Patients. *J Urol* 2016; 196(5): 1371-1377
19. Ploussard G, Haddad R, Loutochin O et al. A combination of hemostatic agents may safely replace deep medullary suture during laparoscopic partialnephrectomy in a pig model. *J Urol* 2015; 193(1): 318-324
20. Zhang Z, Zhao J, Dong W et al. Acute kidney injury after partial nephrectomy: role of parenchymal mass reduction and ischemia and impact on subsequent functional recovery.*Eur*

Urol 2016; 69(4): 745-752

21. Rosen DC, Kannappan M, Paulucci DJ et al. Reevaluating Warm Ischemia Time as a Predictor of Renal Function Outcomes After Robotic Partial Nephrectomy. *Urology* 2018; 120: 156-161
22. Wang Z, Liu C, Chen R et al. Will the kidney function be reduced in patients with renal cell carcinoma following laparoscopic partial nephrectomy? Baseline eGFR, warm ischemia time, and RENAL nephrometry score could tell. *Urol Onco* 2018; 36(11): 498.e15-498.e24.
23. Lane BR, Gill IS, Fergany AF, Larson BT, Campbell SC. Limited warm ischemia during elective partial nephrectomy has only a marginal impact on renal functional outcomes. *J Urol* 2011; 185(5): 1598-1603
24. Bertolo R, Garisto J, Dagenais J et al. Cold Versus Warm Ischemia Robot-Assisted Partial Nephrectomy: Comparison of Functional Outcomes in Propensity-Score Matched "At Risk" Patients. *J Endourol* 2018; 32(8): 717-723
25. Dong W, Wu J, Suk-Ouichai C et al. Ischemia and Functional Recovery from Partial Nephrectomy: Refined Perspectives. *Eur Urol Focus* 2018; 4(4): 572-578
26. Mir MC, Pavan N, Parekh DJ. Current Paradigm for Ischemia in Kidney *J Urol* 2016; 195(6): 1655-1663

Tables

Table 1. Preoperative, intra-operative and postoperative data on 33 patients who underwent surgery

Preoperative variable	Value
Age (Mean±SD), years	59.7 ± 11.1
Gender (female/male ratio)	0.48
BMI (Mean±SD), kg/m ²	26.8 ± 3.2
Left/right kidney	18/15
ASA score (Mean±SD)	1.2 ± 0.4
ECOG score (Mean±SD)	0.3 ± 0.5
Tumor size (Mean±SD), cm	2.7 ± 1.1
R.E.N.A.L. score (Mean±SD)	5.7 ± 1.5
Preoperative eGFR, mL/min/m ²	76.6 ± 22.4
Preoperative hemoglobin, g/dL	13.9 ± 1.3
Intra-operative and postoperative variable	
Operation time (Mean±SD), min	167.9 ± 37.5
Renal artery control (clamped)	27 (81.8%)
Warm ischemia time (Mean±SD), min	11.8 ± 3.9
Blood loss (Mean±SD), mL	104.0 ± 105.8
Transfusion	1 (3.0%)
Conversion to conventional laparoscopy	0
Conversion to open surgery	0
Use of additional port	0
Hospital stay (Mean±SD), day	5.6 ± 1.5
Postoperative eGFR, mL/min/m ²	69.6 ± 24.3
Postoperative hemoglobin, g/dL	13.3 ± 1.3
Skin incision (Mean±SD), cm	2.8 ± 1.1

Table 2. Histopathological results of the 33 patients who underwent surgery

Histopathological variable	Value (N=33)
Clear cell RCC	
pT1a	14 (42.4%)
pT1b	4 (12.1%)
Papillary RCC	
pT1a	3 (9.1%)
Chromophobe RCC	
pT1a	1 (3.0%)
Angiomyolipoma	8 (24.2%)
Oncocytoma	3 (9.1%)
Complications	
Prolong urine leakage	2 (6.1%)
Positive surgical margin	0
Cancer recurrence	0
Duration of follow up (Mean±SD), months	16.5 ± 6.4

Figures

Figure 1

Placement of the LagiPort trocar.

Figure 2

A. A defect after tumor was removed. B. FloSeal was placed into the defect of the kidney. C. Tisseel was then injected to cover the whole hemostatic matrix and surrounding normal kidney surface. D. A fat pad was placed on the top the field covered with Tisseel. FloSeal will swell in the airtight space, like a “pressure cooker”.