

Knotless retroperitoneoscopic nephron-sparing surgery for small renal masses: Comparison of bipolar sutureless technique and barbed suture technique

Journal of International Medical Research

2018, Vol. 46(4) 1649–1656

© The Author(s) 2018

Reprints and permissions:

sagepub.co.uk/journalsPermissions.nav

DOI: 10.1177/0300060518760737

journals.sagepub.com/home/imr



Jianfei Ye*, Shudong Zhang*, Xiaojun Tian, Guoliang Wang, Lei Zhao and Lulin Ma 

Abstract

Objective: Laparoscopic knot-tying and suturing are the most difficult steps in shortening the warm ischemia time and learning curve of laparoscopic nephron-sparing surgery. This study was performed to demonstrate the safety, oncological efficacy, and technical tips of sutureless retroperitoneal laparoscopic nephron-sparing surgery (RPNSS).

Methods: This retrospective study included 78 cases of RPNSS using a sutureless technique and 126 cases of RPNSS using a single-layer barbed self-retaining suture technique performed from December 2012 to December 2016.

Results: The mean warm ischemia time was significantly shorter in the sutureless technique group than in the barbed self-retaining suture technique group (6.8 vs. 21.1 minutes, respectively). There was no significant difference in the mean age, body mass index, R.E.N.A.L. Nephrometry score, operative time, maximal tumor diameter, intraparenchymal depth, blood loss, operative time, transfusion rate, complication rate, or postoperative hospital stay between the two groups. No open conversion was needed. No positive margins or local recurrence were observed during follow-up.

Conclusions: The sutureless technique was proven to be safe and oncologically effective and may allow novice laparoscopic surgeons to easily and quickly master RPNSS, a technically difficult procedure.

Department of Urology, Peking University Third Hospital, Beijing, China

*These authors contributed equally to this work.

Corresponding author:

Lulin Ma, Department of Urology, Peking University Third Hospital, 49 North Garden Road, Haidian District, Beijing 100191, China.

Email: bysyuro@gmail.com



Creative Commons Non Commercial CC BY-NC: This article is distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 License (<http://www.creativecommons.org/licenses/by-nc/4.0/>)

which permits non-commercial use, reproduction and distribution of the work without further permission provided the original work is attributed as specified on the SAGE and Open Access pages (<https://us.sagepub.com/en-us/nam/open-access-at-sage>).

Keywords

Nephron-sparing surgery, retroperitoneal laparoscopy, self-retaining suture, sutureless, warm ischemia time, renal tumor

Date received: 4 August 2017; accepted: 30 January 2018

List of Abbreviations

RPNSS: retroperitoneal laparoscopic nephron-sparing surgery

LNSS: laparoscopic nephron-sparing surgery

WIT: warm ischemia time

Introduction

Nephron-sparing surgery is the standard surgical treatment for small renal tumors (≤ 4 cm in size).¹ Retroperitoneoscopic nephron-sparing surgery (RPNSS) has the advantages of fast recovery, direct control of target organs, and reduced interference from the intestines compared with open or transperitoneal laparoscopic nephron-sparing surgery (LNSS).²⁻⁶ Nevertheless, ensuring hemostatic control and reducing the warm ischemia time (WIT) remain the key surgical concerns in RPNSS. Laparoscopic knot-tying and suturing are the most difficult steps in decreasing the WIT and shortening the learning curve, making this procedure a challenging and highly advanced laparoscopic surgery for most urologists.

Knotless techniques using self-locking clips^{7,8} and barbed self-retaining suture^{9,10} have been introduced and popularized in most institutions to avoid knot-tying during laparoscopy and thus simplify the procedure. Sutureless techniques using hemostatic agents and modalities¹¹⁻¹³ have also been developed to avoid suturing during laparoscopy. To our knowledge, however, this is the first large-volume

study to compare the safety and oncological efficacy of a sutureless technique versus a barbed suture technique. We herein introduce the indications and technical tips of sutureless RPNSS based on our single-center experience.

Patients and methods

Patient selection

Patients who underwent RPNSS from December 2012 to December 2016 at our institution were retrospectively reviewed. Those who underwent RPNSS using a sutureless technique (sutureless group) and those who underwent RPNSS using a barbed technique with 2-0 V-Loc self-retaining suture (V-Loc 180; Covidien, Mansfield, MA, USA) for single-layer suturing (barbed group) were included in this study. The exclusion criteria were a stage $>T1a$ tumor, use of the knot-tying technique, and suturing of more than one layer for a split collecting system.

Preoperative preparation

All patients underwent routine blood tests including liver function tests, renal function tests, and electrolyte measurement as well as radiological imaging including abdominal ultrasound and computed tomography or magnetic resonance imaging of the urinary and vascular systems. Written informed consent was routinely obtained from all patients. We used the R.E.N.A.L. Nephrometry scoring system¹⁴ to evaluate

the baseline difficulty. The post-RPNSS complications were assessed according to the Clavien–Dindo classification system.

Surgical methods

All patients successfully underwent RPNSS without open conversion or conversion to radical nephrectomy. The detailed cost-effective procedure of establishing the retroperitoneoscopic working space has been previously published.¹⁵ Briefly, under general anesthesia, the patient is placed in a lateral decubitus position with flank hyperextension. A 2-cm incision is made below the tip of the 12th rib. The retroperitoneal space is created by expansion using a balloon dilator. A 13-mm trocar is inserted and pneumoretroperitoneum is established under a pressure of 12 mm Hg. The second 11-mm trocar is placed 2 cm above the anterior superior iliac spine, and the third 5-mm trocar is placed at the junction of the anterior axillary line and 2 cm below the margin of the 11th rib. There are four key steps in performing this procedure. First, Gerota's fascia is longitudinally transected to expose the renal pedicle, and the renal artery with or without its accessory arteries is then freely dissected for further clamping. Second, once the tumor is localized, the tumor margins are clearly identified and exposed a few centimeters away from the tumor. The tumor and its overlying fat tissue are removed for pathological examination. Third, after clamping the renal artery, the tumor with about 1 to 5 mm of renal tissue around the nodule is excised with cold scissors. Finally, renorrhaphy is performed; the technique differs between the sutureless and barbed suture procedures. In the sutureless group, the resection bed is carefully examined to rule out large vessel stumps and rupture of the collecting system. The vessel stumps are coagulated with bipolar cauterization or locking clips until the wound bed is clear to exclude any

calyceal defects. In the barbed group, one-layer renal suturing is performed with 2-0 V-Loc barbed self-retaining suture (V-Loc 180, Covidien). The renal artery is then unclamped to detect any bleeding in the renal parenchymal wound, and the wound is covered with hemostatic gauze or hemostatic gel. If the wound is found to have active bleeding in the sutureless group, suturing can be directly performed to ensure hemostasis. After the specimen is retrieved and placed in the specimen bag, a retroperitoneal drainage tube is placed.

Data analysis

Data were collected for further analysis using PASW Statistics for Windows, Version 18.0 (SPSS, Inc., Chicago, IL, USA). Data are shown as mean \pm standard deviation. Statistical significance is assessed with Student's t test and Pearson's chi square test. A p value of <0.05 was considered statistically significant.

Follow-up protocol

Ultrasonography and computed tomography were performed at 6-month intervals after surgery. The serum creatinine level was measured at 3-month intervals after surgery.

Ethics and consent

According to Chinese law, analysis of already available patient-related data acquired during routine hospital treatment does not require approval by an ethics review committee or institutional review board. All patients in this study provided written informed consent for all routine procedures performed, and all consent forms are kept in the patients' medical records with the permission of the Ministry of Health.

Results

Patients

Among 582 patients who underwent RPNSS during the study period, we excluded 128 with a stage >T1a tumor, 34 who underwent a knot-tying technique, and 216 who underwent suturing of more than one layer for a split collecting system. Of the remaining 204 patients, 78 were assigned to the sutureless group and 126 were assigned to the barbed group.

Operative results

The patients' characteristics and results of RPNSS are shown on Table 1. The mean WIT was significantly shorter in the sutureless than barbed group (6.8 vs. 21.1 minutes, $p = 0.022$). There were no statistically significant differences in the mean age, body mass index, operative time, maximal tumor diameter, intraparenchymal depth, R.E.N.A.L. Nephrometry score, blood

loss, operative time, transfusion rate, complication rate, or postoperative hospital stay between the two groups. No open conversion or conversion to radical nephrectomy was needed. Five patients who had been planned to undergo the sutureless technique were converted to the barbed suture technique.

Postoperative results

Seven patients in the sutureless group developed minor complications (Clavien–Dindo Grade I–II), all of which were cured with conservative treatment. These complications comprised four cases of postoperative fever cured with antibiotic treatment, one case of postoperative hemorrhage cured by blood transfusion, one case of lower extremity venous thrombosis, and one case of postoperative transient elevation of the serum creatinine level (1.70 mg/dL). In the barbed group, one patient developed a major complication (Clavien–Dindo Grade \geq III) requiring interventional embolization

Table 1. Patient characteristics and operative outcomes

	Sutureless group	Barbed group	Total	p
Patients (n)	78	126	204	
Sex (male/female, n)	49/29	71/55	120/84	
Age (years)	52.7 ± 13.4	53.7 ± 8.3	53.3 ± 8.7	0.532
Side (left/right)	41/37	74/52	115/89	
Body mass index (kg/m ²)	23.9 ± 4.0	24.6 ± 3.1	24.3 ± 3.9	0.521
Maximal diameter (mm)	2.12 ± 0.7	2.89 ± 0.9	2.6 ± 0.8	0.052
Intraparenchymal depth (mm)	7.1 ± 3.9	16.2 ± 9.1	12.7 ± 7.9	0.096
R.E.N.A.L. Nephrometry score	4.8 ± 0.8	6.5 ± 1.9	6.03 ± 1.8	0.088
Operative time (min)	131.0 ± 48.1	148.3 ± 28.1	141.7 ± 35.1	0.598
Warm ischemia time (min)	6.8 ± 1.2	21.1 ± 1.9	15.6 ± 1.4	0.022*
Blood loss (mL)	83.6 ± 57.3	78.4 ± 51.6	80.4 ± 52.9	0.512
Transfusion rate (%)	1.3	5.6	4.0	0.439
Open conversion (n)	0	0	0	
Complication rate (%)	9	7.1	7.8	0.763
Postoperative stay (days)	5.9 ± 2.4	6.2 ± 2.2	6.1 ± 2.2	0.779
Preoperative creatinine (mg/dL)	71.9 ± 13.9	74.8 ± 12.6	73.7 ± 12.9	0.587
Postoperative creatinine (mg/dL)	77.9 ± 2.8	81.3 ± 2.2	80.0 ± 2.6	0.592
Follow-up (months)	47.2 ± 7.3	49.3 ± 12.4	48.5 ± 10.3	0.835

Data are presented as mean ± standard deviation unless otherwise indicated.

of a renal artery branch because of massive bleeding, and eight patients developed minor complications that were cured with conservative treatment. The minor complications comprised five cases of postoperative fever, two cases of massive drainage without urinary leakage, and one case of postoperative intestinal obstruction treated by conservative treatment. No positive margins or local recurrence were observed during the median follow-up of 48.5 months. The pathological results are shown in Table 2.

Discussion

Nephron-sparing surgery has been recommended as a preferred method for the treatment of stage T1 renal masses when applicable because it not only effectively controls the tumor but also provides superior functional outcomes compared with radical nephrectomy.¹ LNSS has been widely accepted because of its minimal invasiveness and convalescence

benefits.^{2,5,16} RPNSS provides direct control of the target organs and reduces interference from the intestines compared with transperitoneal LNSS.^{2,3} However, time-consuming intracorporeal suturing and knot-tying for homeostasis and renal parenchymal repair within 30 minutes of WIT are the most technically difficult steps for novice laparoscopic urologists. Various techniques have been reported to avoid knot-tying and suturing during laparoscopy and thus simplify this technically advanced procedure.⁷⁻¹⁰ To avoid the time-consuming and technically demanding intracorporeal knot-tying, a knotless technique was introduced using Lapra-Ty absorbable clips (Ethicon Endo-Surgery, Cincinnati, OH, USA),⁷ Hem-o-Lok clips (Weck Closure Systems, Research Triangle Park, NC, USA),⁸ Quill sutures (Angiotech Pharmaceuticals, Reading, PA, USA),⁹ and V-Loc sutures (Covidien).¹⁰ Self-locking clips can facilitate suturing by avoiding knot-tying and maintaining adequate compression of the renal tissue with cinched sutures to prevent the parenchymal edge from slipping.^{7,8} With further developments, novel barbed sutures were introduced for renorrhaphy with the advantages of a shortened WIT and decreased urinary complication rate.^{9,10} Therefore, the barbed technique is accepted worldwide, including in our institution, where we have achieved surgical safety and oncologic efficacy comparable with that reported in the literature.^{17,18} In the present study, the blood loss, operative time, transfusion rate, complication rate, WIT, and postoperative recovery of this technique were acceptable, with favorable safety and effectiveness. Therefore, comparison with the barbed group as a control was used to demonstrate the expertise of RPNSS at our institution.

To avoid intracorporeal suturing and additional loss of the functional renal parenchymal suturing edge, sutureless

Table 2. Pathological outcomes

	Sutureless group	Barbed group	Total
Pathology			
Clear cell cancer	51	73	124
Angiomyolipoma	15	22	37
Renal cyst	6	7	13
Chromophobe	3	6	9
Papillary renal cancer	2	6	8
Oncocytoma		6	6
Neurinoma		1	1
Necrosis		2	2
Juxtaglomerular cell tumor		1	1
Tuberculosis		1	1
Wilms' tumor	1		1
No tumor		1	1
Positive margin	0	0	0
Recurrence	0	0	0

Data are presented as number of patients.

techniques have also been developed for LNSS using hemostatic agents and modalities such as glues, bolsters, lasers, and electrocoagulation.^{12,13,19,20} However, sutureless techniques have only been reported in isolated case series or limited cases with comparison of knot-tying suture repair.^{12,13,21} Although the feasibility of such techniques has been previously demonstrated in the literature, the long-term oncological outcomes, specific indications, and technical tips remain unclear.

Compared with the barbed control group, which showed favorable safety and effectiveness, the sutureless RPNSS technique was also acceptable in terms of a comparable complication rate, postoperative recovery, positive margins, and follow-up outcomes. The advantage of the sutureless technique is the avoidance of laparoscopic knot-tying and suturing, leading a reduced WIT and easy tissue manipulation. This technique may encourage laparoscopic novices to learn and master this technically demanding surgery. However, it is also important for novice surgeons using this technique to have an experienced surgeon available for unexpected failure in the initial cases.

The indications for the sutureless RPNSS technique include a tumor diameter of <4 cm, intraparenchymal depth of <2 cm, and a <1-mm border from the tumor to the collecting system. Conversion to a suturing technique is needed if satisfactory bleeding control cannot be attained. Five patients who were planned to undergo the sutureless technique underwent such conversion because of an open incision of the collecting system or unsatisfactory bleeding control. Thus, it is important for surgeons to be able to perform simple suturing even if it is time-consuming. Four technical tips should be kept in mind during this operation. First, it is important to determine whether a >1-mm gap is present

between the tumor and collecting system on radiographic images. Second, strict hemostasis of the resection bed should be ensured by placing clips on the vessel stumps and using bipolar coagulation until the hemostasis is satisfactory. Third, the surgeon should carefully check for tiny defects of the collecting system on the tumor resection bed. Finally, the surgeon should prepare a self-retaining suture and not hesitate to suture the bleeding resection bed if the hemostasis is not satisfactory or any calyceal defect is present.

The main limitation of this study is its retrospective nature and potential selection bias caused by the preoperative radiographic judgments and individual expertise. Additionally, the significant difference in the intraparenchymal depth of the renal masses between the two groups may have led to the decreased WIT. Nevertheless, no significant differences were found in safety or oncological efficacy, and this sutureless technique may therefore give novice surgeons some confidence. The complications in the sutureless group were acceptable. One patient in the sutureless group developed massive postoperative drainage and was cured by conservative treatment involving cessation of urine leakage. Another patient developed postoperative thrombosis in a lower limb vein and was treated by anticoagulation without renal wound bleeding. The postoperative serum creatinine concentration of another patient was transiently elevated at 1.70 mg/dL but returned to normal 2 weeks later. The other four patients developed a postoperative fever that resolved with conservative treatment. No urine leakage or other complications occurred. No significant difference was observed in the transfusion rate, postoperative hospital stay, or incidence of complications between the two groups. No positive margin or local recurrence was observed postoperatively.

Conclusions

Compared with the barbed suture technique, the sutureless RPNSS was proven to be safe and oncologically effective. Because it is free from laparoscopic knotting and suturing, it may encourage novice laparoscopic surgeons to more confidently and quickly master this technically demanding procedure.


Declaration of conflicting interests

The authors declare that there is no conflict of interest.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

ORCID iD

Lulin Ma  <http://orcid.org/0000-0001-6213-7975>

References

- Ljungberg B, Bensalah K, Canfield S, et al. EAU guidelines on renal cell carcinoma: 2014 update. *Eur Urol* 2015; 67: 913–924.
- Gin GE, Maschino AC, Spaliviero M, et al. Comparison of perioperative outcomes of retroperitoneal and transperitoneal minimally invasive partial nephrectomy after adjusting for tumor complexity. *Urology* 2014; 84: 1355–1360.
- Marszalek M, Chromecki T, Al-Ali BM, et al. Laparoscopic partial nephrectomy: a matched-pair comparison of the transperitoneal versus the retroperitoneal approach. *Urology* 2011; 77: 109–113.
- Ng CS, Gill IS, Ramani AP, et al. Transperitoneal versus retroperitoneal laparoscopic partial nephrectomy: patient selection and perioperative outcomes. *J Urol* 2005; 174: 846–849.
- Becker A, Pradel L, Kluth L, et al. Laparoscopic versus open partial nephrectomy for clinical T1 renal masses: no impact of surgical approach on perioperative complications and long-term postoperative quality of life. *World J Urol* 2015; 33: 421–426.
- Klaassen Z, Kohut RJ, Patel D, et al. A single surgeon's experience with open, laparoscopic, and robotic partial nephrectomy. *Int Sch Res Notices* 2014; 2014: 430914.
- Orvieto MA, Chien GW, Tolhurst SR, et al. Simplifying laparoscopic partial nephrectomy: technical considerations for reproducible outcomes. *Urology* 2005; 66: 976–980.
- Canales BK, Lynch AC, Fernandes E, et al. Novel technique of knotless hemostatic renal parenchymal suture repair during laparoscopic partial nephrectomy. *Urology* 2007; 70: 358–359.
- Shikanov S, Wille M, Large M, et al. Knotless closure of the collecting system and renal parenchyma with a novel barbed suture during laparoscopic porcine partial nephrectomy. *J Endourol* 2009; 23: 1157–1160.
- Seideman C, Park S, Best SL, et al. Self-retaining barbed suture for parenchymal repair during minimally invasive partial nephrectomy. *J Endourol* 2011; 25: 1245–1247.
- Simforoosh N, Noor-Alizadeh A, Tabibi A, et al. Bolsterless laparoscopic partial nephrectomy: a simplification of the technique. *J Endourol* 2009; 23: 965–969.
- Minervini A, Siena G, Tuccio A, et al. Sutureless hemostatic control during laparoscopic NSS for the treatment of small renal masses. *Surg Innov* 2014; 21: 32–38.
- Kihara K, Koga F, Fujii Y, et al. Gasless laparoendoscopic single-port clampless sutureless partial nephrectomy for peripheral renal tumors: perioperative outcomes. *Int J Urol* 2015; 22: 349–355.
- Kutikov A and 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: 844–853.
- Ye J, Huang Y, Hou X, et al. Retroperitoneal laparoscopic live donor nephrectomy: a cost-effective approach. *Urology* 2010; 75: 92–95.

16. Laviana AA and Hu JC. Current controversies and challenges in robotic-assisted, laparoscopic, and open partial nephrectomies. *World J Urol* 2014; 32: 591–596.
17. Zondervan PJ, Gozen AS, Opondo D, et al. Partial nephrectomy: is there an advantage of the self-retaining barbed suture in the perioperative period? A matched case-control comparison. *World J Urol* 2012; 30: 659–664.
18. Erdem S, Tefik T, Mammadov A, et al. The use of self-retaining barbed suture for inner layer renorrhaphy significantly reduces warm ischemia time in laparoscopic partial nephrectomy: outcomes of a matched-pair analysis. *J Endourol* 2013; 27: 452–458.
19. Ogan K, Jacomides L, Saboorian H, et al. Sutureless laparoscopic heminephrectomy using laser tissue soldering. *J Endourol* 2003; 17: 295–300.
20. Louie MK, Gamboa AJ, Kaplan AG, et al. Bovine serum albumin glutaraldehyde for completely sutureless laparoscopic heminephrectomy in a survival porcine model. *J Endourol* 2010; 24: 451–455.
21. Simone G, Papalia R, Guaglianone S, et al. 'Zero ischaemia', sutureless laparoscopic partial nephrectomy for renal tumours with a low nephrometry score. *BJU Int* 2012; 110: 124–130.