Endo-Satinsky Clamp Hybrid In Situ Perfusion in Retroperitoneoscopic Donor Nephrectomy For Right-sided Kidney

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OBJECTIVE To introduce our hybrid technique using an endo-Satinsky clamp and in situ cold perfusion for right-sided retroperitoneoscopic donor nephrectomy (RDN) and to investigate efficacy and safety compared with those standard right-sided RDN.

METHODS This retrospective study included 16 transplant donors who underwent right-sided RDN from January 2016 to January 2018. Donors received either hybrid RDN ($n = 6$) or standard RDN ($n = 10$). Perioperative outcomes, including operative time, estimated blood loss, warm ischemic time, hospital stay, length of renal vein obtained as well as postoperative renal function of their recipients were collected and compared between the hybrid RDN and standard RDN groups.

RESULTS Procedures were performed successfully in all 16 donors. The hybrid RDN group required longer operation times (135 vs 115 minutes), demonstrated increased blood loss (175 vs 140 mL), but shorter warm ischemic times (1.5 vs 5.5 minutes) and resulted in longer length of the procured renal vein (2.8 vs 1.7 cm) as compared with the standard RDN group. No difference in perioperative complication rates was witnessed between the 2 groups. Also, there were no significant differences in serum creatinine levels and glomerular filtration rates of recipients between the 2 groups at both postoperative day 3 and 1 month.

CONCLUSION The hybrid RDN potentially extends the length of the right donor renal vein. The perioperative outcomes of hybrid RDN were comparable with those of the standard RDN. This hybrid technique can be a technically safe and feasible option for right kidney donation. UROLOGY 130: 191–195, 2019. © 2019 Elsevier Inc.

Kidney transplantation is considered the most effective treatment option for patients with end-stage renal disease.[1] Currently, a worldwide increased demand for living kidney donation has been experienced. The traditional technique for living-donor nephrectomy is open surgery,[2] which results in a lengthy hospital stay and significant postoperative pain. In 1995, laparoscopic donor nephrectomy (LDN) was introduced as a less invasive alternative to living kidney procurement.[3] The advantages of a LDN technique compared with open surgery include decreased blood loss, reduced analgesic requirements, a shorter stay in the hospital, and a faster recovery form surgical trauma.[4,5] Therefore, LDN has become a standard procurement procedure for living donor kidneys.[6]

Left donor kidney is generally preferred for laparoscopic removal due to the resulting longer renal vein. However, right donor nephrectomy is occasionally preformed in the presence of multiple vessels on the left, or incidental anatomic abnormalities (cysts or stones, etc.) on the right.[7,8] Modifications have been made in LDN, such as hand-assisted retroperitoneoscopic laparoscopic nephrectomy, allowing to preserve a longer right renal vein and reduce both operating time and warm ischemia time. However, this technique requires a hand-assisted port created prior to operation thereby increasing the iatrogenic trauma and affecting the operation space.[9] For these reasons, some institutions prefer the open donor nephrectomy to procure the right-sided kidney.

In 2014, Kim et al reported a hybrid technique using a Satinsky clamp for right-sided transperitoneal hand-assisted LDN and found that the perioperative outcomes of this hybrid technique were comparable with those of the left-sided standard hand-assisted LDN.[10] The right-sided kidney donors increased during 2010-2016 at our

Funding: *This study was supported by the National Natural Science Foundation of China (No. 81400761). The funders had no role in study design, data collection, data analysis, decision to publish, or preparation of the report.*

Conflict of Interest: *The authors declare that they have no conflict of interest.*

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institution, representing about 25% of all living donors. In this study, we introduced a modified hybrid technique using an endo-Satinsky clamp and in situ cold perfusion for right-sided retroperitoneoscopic donor nephrectomy (RDN). The efficacy and safety of this hybrid RDN were assessed in comparison with standard RDN.

MATERIALS AND METHODS

Donors

We retrospectively reviewed the medical records of 16 donors, who received right-sided RDN at the Xinqiao Hospital, the Army Military Medical University between June 2016 and June 2018. The study protocol was approved by the Ethics Committee of the Army Military Medical University. All subjects provided their written consent. In our institution, all transplant donors were thoroughly screened for medical history, physical examination, and laboratory tests, including blood and urinary biochemical tests and cross matching tests. Preoperative assessment of renal vascular anatomy and dynamic radionuclide renal imaging were performed on all donors. The 16 donors included were previously scheduled for right-sided nephrectomy due to the presence of the multiple renal arteries and/or veins.

Surgical Procedures

All procedures were performed in our center by 6 credentialed surgeons, including 4 professors and 2 attending surgeons who participated in organ procurement and transplantation surgery. All complications were classified according to the modified Clavien grading system.[11] Operation time was defined as "skin-to-skin" time, in other words, the interval between incision and placement of the final suture. Warm ischemia time was calculated from the time when the first artery was blocked by bulldog clamp to the time when kidney was flushed with University of Wisconsin (UW) solution. Intraoperative blood loss was evaluated by measuring the volume of blood in the suction drain as well as weighing blood stained gauzes.

The patient was placed in the left full-flank, with surgeons standing on the back side of the patient.[12,13] For the standard RDN procedures, the retroperitoneal space was dilated using a self-made rubber glove balloon. Along the anterior axillary line, a 12 mm camera port was placed at the tip of the 12th rib. The additional trocars were positioned on the axillary line and on the midclavicular line below the costal margin, respectively. Then, the kidney, ureter, and vascular structures were carefully dissected. The renal artery was controlled using 2 single Hem-o-lok clips (Weck Closure Systems, Research Triangle Park, Durham, NC) and divided sharply distal to the 2 clips. The renal vein was also controlled by placing 2 Hem-o-lok clips on the inferior vena cava (IVC) side. The hybrid procedures were performed similarly to standard RDN. Briefly an endo-Satinsky clamp (Braun Melsungen AG, Hessen, Germany) with 26.5 cm long and 35-mm jaws was uniquely introducted into the retroperitoneal space through the additional trocar and placed on the IVC to control the renal vein. Maximizing the preserved length of renal vein was the intended use of the endo-Satinsky clamp (Fig. 1A). The renal vein was dissected with laparoscopic scissors (Fig. 1B), and renal artery was cannulated with an infusion tube for in situ cold perfusion with lactated Ringer's solution until the kidney appeared whitish on a monitor (Fig. 1C). The IVC defect was sutured using a 5-0 polypropylene running suture on a 17 mm tapered needle (Fig. 1D), with tying 6 knots at the beginning and the end of the suture line, respectively.[14] All suturing was performed laparoscopically.

Recipients

All transplant recipients received an identical immunosuppression regimen consisting of induction with rabbit antithymocyte globulin, followed by triple maintenance immunosuppression with tacrolimus, mycophenolic acid, and prednisone. Pre- and postoperative estimated serum glomerular filtration rates were

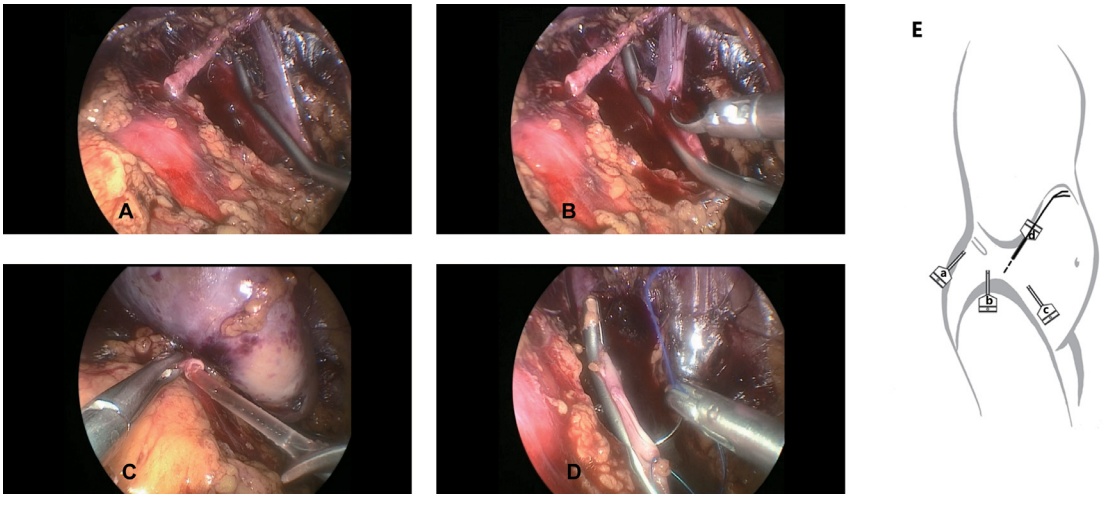

Figure 1. Surgical procedures of hybrid RDN. (A) An endo-Satinsky clamp with 26.5 cm long and 35-mm jaws was introduced into the retroperitoneal space through the additional trocar and placed on the IVC. (B) The renal vein was dissected with laparoscopic scissors. (C) Renal artery was inserted with an infusion tube for in situ cold perfusion with lactated Ringer's solution. (D) The IVC defect was sutured using a 5-0 polypropylene running suture on a 17 mm tapered needle. (E) Port placement and pfannenstiel incision in right (a and c 12 mm working port; b 12 mm camera port; d 5 mm accessory port). (Color version available online.)

Table 1. Baseline characteristics of subjects

Donors	Hybrid RDN ($n = 6$)	Standard RDN ($n = 10$)	*P* Value
Age, years	48 (40-59)	49 (39-62)	.579
Female, *n* (%)	3 (50.0)	4 (40.0)	.549
BMI, kg/m^2	23.4 (20-27)	21.3 (21-28)	.072
Arteries >1, *n* (%)	2 (33.3)	2 (20.0)	.489
eGFR, mL/min/1.73 m^2	92 (89-105)	95 (86-113)	.202

RDN, retroperitoneoscopic donor nephrectomy.
Continuous data are presented as median (range).

recorded.[12] Recipients were followed up for 3 months to evaluate graft survival.

Statistical Analysis

Statistical analysis was conducted using SPSS 18.0 software (SPSS Inc, Chicago, IL). Comparisons of continuous variables between the groups were performed using Student's *t* tests. Categorical variables were compared using chi-square test. A *P* value <.05 was considered significant.

RESULTS

This study included 16 kidney donors among whom 6 underwent the hybrid RDN operation and 10 donors underwent the standard RDN procedure. Their baseline characteristics are shown in Table 1.

Intraoperative Outcomes

Patients undergoing hybrid RDN had significantly longer median skin-to-skin time, but shorter median warm ischemia time, as compared the patients undergoing standard RDN (Table 2). Moreover, patients in the hybrid RDN group had increased blood loss compared to those in the standard RDN group. Blood transfusion was required in 2 donors, one in each group, due to significant blood loss of more than 200 mL.

Postoperative Outcomes

All 16 donors and their recipients completed the records at 1 month after surgery. Among donors, hybrid RDN persevered longer lengths of the renal veins compared with standard RDN. No significance was found in terms of hospital stay, reoperation rate, and total morphine requirement.

None of the recipients in either group experienced delayed graft function. There were no significant differences in graft function as well as graft survival between the recipients of the 2 groups.

DISCUSSION

There are 3 major types of LDN, the traditional LDN, hand-assisted LDN, and robotic LDN. Although robotic surgery has gained popularity in recent years, the excessive cost limits its application.[15] Thus, many studies focus on the comparison of efficacy and safety between LDN and hand-assisted LDN procedures, which show similar effectiveness and rates of complications.[16,17] Some researchers believe that the hand-assisted LDN may significantly increase the touching sensitivity and reduce the warm ischemic time.[18] We began to perform the LDN at our institution in 2012. According to our experiences, the hand port of the hand-assisted LDN is needless, as this device occupies space in the operative field and adds to the operational complexity, particularly in the retroperitoneal space. Moreover, the hand port is typically placed at the beginning of surgery, which may increase the risk of iatrogenic trauma before kidney separation. In the UK, approximately one-third of all LDN procedures are

Table 2. Intraoperative and postoperative outcomes of donors and recipients

	Hybrid RDN ($n = 6$)	Standard RDN ($n = 10$)	*P* value
Donors			
Intraoperative skin-to-skin time, min	135 (124-155)	115 (105-136)	.013
Warm ischemia time, min	1.5 (1-2.5)	5.5 (4.5-7)	.013
Blood loss, mL	175 (145-220)	140 (100-210)	.038
Postoperative hospital stay, days	4.5 (4-6)	5.5 (4-7)	.02
Reoperation, *n* (%)	0 (0)	0 (0)	1
Morphine requirement, *n* (%)	1 (16.7)	2 (20)	.69
Length of vein, cm	2.8 (2.4-3.3)	1.7 (1.5-2.0)	.015
Postoperative serum creatinine at 3 day, mg/dL	1.16 (1.04-1.40)	1.15 (1.03-1.38)	.56
Postoperative serum creatinine at 1 month, mg/dL	1.13 (1.06-1.39)	1.14 (1.03-1.37)	.58
Recipients			
Incidence of DGF, *n* (%)	0 (0)	0 (0)	1
Postoperative serum creatinine at 3 day, mg/dL	1.52 (1.34-1.74)	1.53 (1.35-1.78)	.48
Postoperative serum creatinine at 1 month, mg/dL	1.43 (1.23-1.60)	1.48 (1.26-1.62)	.54
One-year graft survival, *n* (%)	6 (100)	10 (100)	.88

DGF, delayed graft function.
Continuous data are presented as mean (±SD) or median (range).

performed using a retroperitoneal approach.[19] The training of LDN in China is significantly different from that seen in the US and Europe, and Chinese urologists are accustomed to the retroperitoneoscopic LDN.[20] However, it seems inconvenient to operate with a hand-assisted port in a very small retroperitoneal operating space, especially for those obese patients.

The use of LDN to procure the right-sided kidney is controversial, since the right-sided renal vein is anatomically shorter than that on the left. Studies indicated that anastomosis of a short renal vein was associated with renal vein thrombosis, and some institutions, thus, preferred the open donor nephrectomy rather than LDN to procure the right-sided kidney.[21,22] On the contrary, other studies demonstrated that right-sided LDN produced fewer complication rates and shorter operation times, and there was no significant difference in allograft function of left vs right-sided kidney procured by LDN.[23,24] In our previous work, we used the hand-assisted approach or stapler to acquire the donor kidneys.[17,24] To assure the safety of donors, we often utilized 1 Hem-o-lok clip before applying the stapler. Ultimately, we found that these methods still failed to lengthen the renal vein, causing difficulties when performing venous anastomosis. Furthermore, the use of a stapler costs at least $1000, leading to an increased economic burden on the family, notably in countries like China, where very few families can afford the procedure. Some researchers have made efforts to extend the renal veins by renal vein reconstruction with, for instance, the gonadal vein and iliaca vessels.[25-27] The shortcoming of these approaches, however, requires advanced laparoscopic skills for vascular anastomosis, which necessitates a lengthy term of study. In our institution, we had applied the gonadal veins for vascular reconstruction and extension of the renal vein. Although most of the recipients showed promising surgical outcomes, it was necessary to monitor the postoperative stricture or thrombosis of the renal vein by doppler ultrasound over a long duration after surgery, and as a result, caused cost increases and prolonged hospital stays. Since 2016, we have worked to establish a modified RDN technique for kidney procurement based on the findings of previous work.[10,14] This study provides a feasible alternative of LDN, which better assures the length of renal vein procurement, overall cost reduction, and most importantly, decrease in the risks of postoperative stricture or thrombosis of the renal vein. However, there is still a need for LDN training for the anastomosis of IVC defect.

In this study, we used in situ cold perfusion of kidney grafts with lactated Ringer's solution instead of irrigation at the bench.[28] This method could lower kidney temperature and remove blood clots or leukocytes immediately. Owing to persistent perfusion with solution until separation of the renal vein, the blood potassium concentration and body temperature were maintained stable, as evidenced by the values of arterial blood gas monitoring during the operation. Our findings are in accordance with the results of previously published studies, which indicates that the artery perfusion was stable and safe, establishing a better alternative to ice slush around the kidney or transureteral cold perfusion in line with physiological conditions.[29,30] Also, the delayed graft function incidences and graft survival rates did not differ between the hybrid RDN and standard RDN groups, further proving hybrid RDN as a feasible option for donor kidney procurement. Still, this technique requires advanced laparoscopic operation skill, which might in turn limit its popularization.

In conclusion, our study provides evidence that RDN with an endo-Satinsky clamp through retroperitoneum and in situ perfusion for procuring the right-sided kidney is a safe and feasible alternative technique to RDN. However, limitations of this study included single-center design and a small sample size. Thus, the findings need further confirmation with a larger sample size and an extended time for follow-up.

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