

Laparoscopy/Robotics

Hand-Assisted Laparoscopic Right Donor Nephrectomy: Safety and Feasibility

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Purpose: We aimed to prove the safety and feasibility of right-sided hand-assisted laparoscopic donor nephrectomy (HALDN).

Materials and Methods: Between May 2006 and May 2009, 16 patients underwent right-sided HALDN at our institution. Of these patients, 15 showed significantly lower renal function in the right kidney than in the left one and 1 had a stone in the right kidney. When the right renal vein was divided, an EndoGIA stapling device was placed on the wall of the inferior vena cava to gain a maximal length of the vein. We evaluated intraoperative and postoperative parameters such as operative time, delivery time, warm ischemic time, estimated blood loss, intraoperative and postoperative complication rates, length of hospital stay, and serum creatinine levels of donors (at the time of discharge) and recipients (4 weeks postoperatively), comparing the right-sided HALDN group (our study) with a left-sided HALDN group (from a previously reported study).

Results: A total of 16 right-sided HALDNs were successfully performed without any complications or open conversion. All of the intraoperative and postoperative parameters were similar between the right-sided HALDN and left-sided HALDN groups. There were no technical problems in the recipients in the anastomosis of the renal vein, and the ureteral anastomoses were also successful.

Conclusions: Right-sided HALDN is safe and technically feasible in a donor, showing favorable graft outcomes. The results of our study suggest that right-sided HALDN may be preferable in patients with significantly lower renal function in the right kidney than in the left one.

Key Words: Laparoscopy, Living donors, Nephrectomy, Hand

Article History:

received 21 August, 2009

accepted 29 September, 2009

See Editorial on page 39.

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INTRODUCTION

Hand-assisted laparoscopic donor nephrectomy (HALDN) has become the method of choice for removing living donor kidneys. Similar to open live donor nephrectomy cases, however, most laparoscopic donor nephrectomy cases have been limited to the left side because of the longer renal vein than on the right side, the greater technical ease of transplantation, and reasonable positioning of the transplanted kidney in a recipient [1,2]. In addition, although there have been debates about this issue, some authors have emphasized the left-side preference by arguing that left-sided HALDNs are successful even in cases with multiple left renal arteries [1,3-5]. Obviously, several indications, including significantly lower function in the right kidney than in

the left one [6-10] or a woman of child-bearing age [7,11], should prompt consideration of the right rather than the left kidney. However, fewer reports have been made on right laparoscopic donor nephrectomy because most right donor nephrectomies have been performed in open surgery owing to a lack of experience and the technical difficulties in performing laparoscopic procedures. Moreover, the surgical outcomes of right laparoscopic donor nephrectomies (especially HALDNs) have not yet been reported in Korea. The aim of this study, therefore, was to report the safety and feasibility of right-sided HALDN.

MATERIALS AND METHODS

Between May 2006 and May 2009, 16 patients underwent

right-sided HALDN in our institution, by the same operator, who had experienced more than 500 cases of open donor nephrectomies and more than 300 cases of left-sided HALDNs. We retrospectively analyzed these cases after collecting demographic information on donors including age, sex, relation to a recipient, body mass index (BMI), and indications for the right-sided approach. Preoperative donor evaluation included history taking, physical examination, laboratory tests, renal ultrasonography, intravenous pyelography (IVP), and renal function testing by radio-nuclide renal scan (99mTc-diethylenetriamine penta-acetic acid; DTPA). Three-dimensional spiral computerized tomography was used to define the renal parenchyma and vasculature.

Surgical demographics included intraoperative and postoperative parameters such as operative time, delivery time, warm ischemic time (WIT), estimated blood loss

(EBL), intraoperative and postoperative complication rates, length of hospital stay (LOS), and serum creatinine levels of donors (at the time of discharge) and recipients (4 weeks postoperatively). Operative time was defined as the time interval from the initial skin incision to closure of the skin. Delivery time was calculated as the time interval from renal artery stapling to being placed in ice slush, and WIT was calculated as the time interval from renal artery stapling to back-table flushing. LOS was defined as postoperative hospital stay.

Our surgical procedures were as follows. Under general endotracheal anesthesia, the patient was placed on a flexed table in a left-down partial flank position. An axillary roll was placed beneath the donor's arm, and the right arm was maintained on an armrest. A 6 to 8 cm incision was made for the hand (A) below the umbilicus along the border of the right rectus muscle, and an 11 mm trocar was placed 5 cm above the hand port for the camera (B). A 12 mm trocar (C) was placed 5 cm above the camera port for the Hem-o-lok (Weck Closure Systems, Research Triangle Park, USA) or EndoGIA (ConMed, New York, USA), and we performed most of our procedures through this port. Additionally, a 5 mm trocar (D) was placed below the xiphoid process for liver retraction. When needed, we placed an additional 10 mm trocar at the right subcostal margin in the right mid-clavicular line (Fig. 1). With the left hand in the abdomen, we incised the Gerota's fascia and entered the perirenal space after incising the lateral line of Toldt and medially reflecting the ascending colon and duodenum. For complete mobilization of the kidney, the perirenal fat and adjacent tissues were sufficiently dissected. The ureter was dissected to the level of the external iliac vessels and divided, leaving enough margins to ensure blood supplies around it. Then, the ascending colon, right transverse colon, and duodenum were widely mobilized to provide a maximal exposure of the right renal hilum and inferior vena cava (IVC). The renal hilum was skeletonized by meticulous dissection of its adjacent structures with great care to avoid any injuries to the hilar vessels (Fig. 2A). A harmonic scalpel (Ultracision[®]; Ethicon Endo-surgery, Flower Mound, USA) was used in all of these procedures

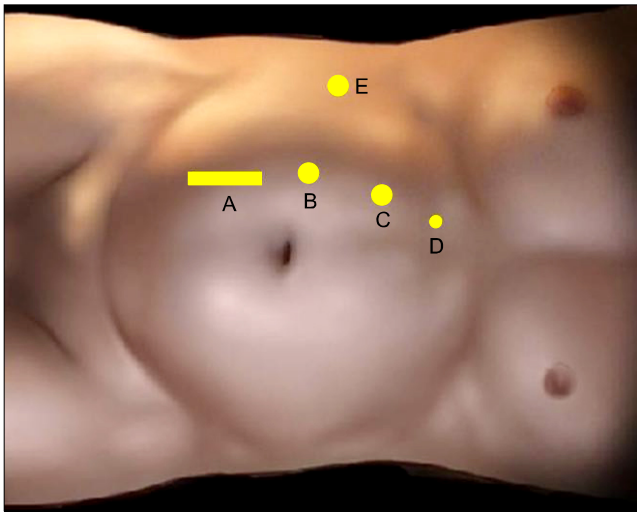


FIG. 1. Port placement for right-sided hand-assisted laparoscopic donor nephrectomy (HALDN). (A) Hand port. (B) 11 mm port for a camera. (C) 12 mm port for right-hand working instruments including Hem-o-lock or EndoGIA stapler. (D) 5 mm port for liver retraction. (E) Additional 10 mm port (optional).

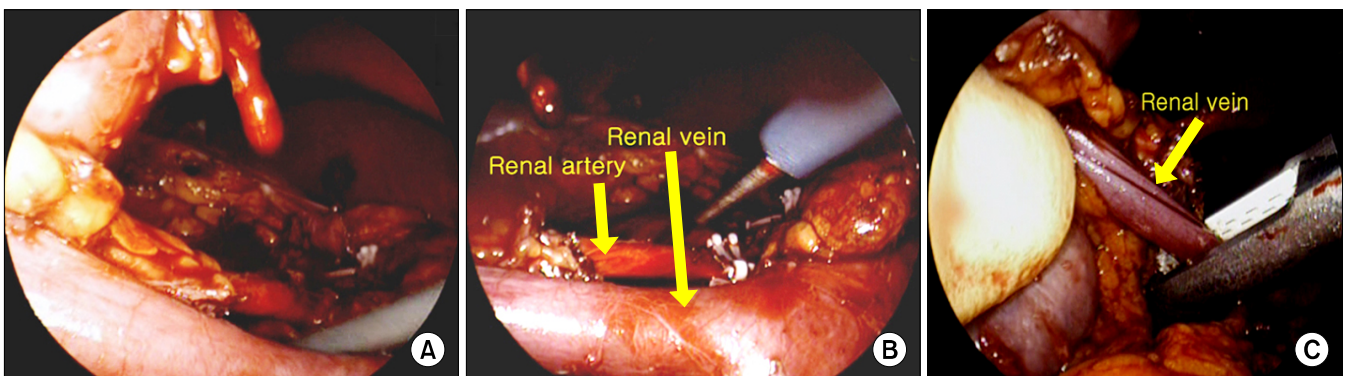


FIG. 2. Skeletonization of the right renal hilum (A), clamping and dividing of the right renal artery (B), and endoGIA stapling of the right renal vein (C).

for the dissection and coagulation of tiny vessels and other peritoneal structures. After 25% mannitol (250 ml) and diuretics were intravenously administered 20 minutes before arterial clamping, the renal artery was clamped with 2 or 3 Hem-o-loks and divided (Fig. 2B), and a 30 mm EndoGIA stapler was used to transect the renal vein. To gain a maximal length of the right renal vein, the kidney must be gently retracted laterally with the help of the surgeon's left hand to extend the right renal vein, and the EndoGIA stapler must be positioned at the junction of the IVC and right renal vein (Fig. 2C). Thereafter, the right kidney was removed by the surgeon's left hand through the hand-port device. The kidney was immediately placed in sterile slush. The staple lines were excised, and the artery was flushed with cold kidney preservation solution. Then, the kidney was delivered to the recipient team for grafting. After the abdomen was carefully reinspected at a reduced intraperitoneal pressure, bleeding was controlled, and a JP drain was inserted. The trocars were all removed under direct vision, and the pneumoperitoneum was evacuated. The wounds were closed in the usual fashion.

RESULTS

The procedures were successfully performed on all 16 patients, and none of the patients experienced intraoperative complications or required conversion to laparotomy. The mean age of the donors was 38.3±10.4 years, the ratio of males to females was 1.71:1, and the mean BMI was 23±8.0. The reasons for right donor nephrectomy were as follows:

≥10% difference in split renal function as determined by radionuclide renal scan DTPA (n=15) and right renal stone (n=1). The numbers of right renal arteries of the 16 patients were as follows: single renal artery (n=13), single renal artery with an early branching artery that supplied the upper pole of kidney (n=2), and duplicated renal artery (n=1). The numbers of right renal veins of the patients were as follows: single renal vein (n=15), duplicated renal vein (n=1). The numbers of left renal arteries and veins are shown in Table 1. The preoperative and postoperative parameters of our study are presented in Table 1. The mean operative time in our series was 192.1±31.6 minutes, with a mean delivery time of 122.2±22.4 seconds, a mean WIT of 191.8±42.5 seconds, a mean EBL of 199.0±71.4 ml, and a mean LOS of 4.18±0.39 days. The mean serum creatinine level in the donors was 1.17±0.19 mg/dl at discharge. Concerning graft function, the mean serum creatinine level on day 28 was satisfactory in the recipients (1.16±0.18 mg/dl). No major or minor complications occurred in any of the 16 patients who underwent our right-sided HALDN during the step of clipping and dividing the renal vessels of the donors. As for the recipients, there were no technical problems in the anastomosis of the renal vein, and ureteral anastomoses were also successful without any postoperative sequelae such as ischemic ureteral stricture or leakage of urine. In the case of the donor who had a right renal stone, the stone-bearing kidney was transplanted and the recipient underwent subsequent successful elective shock wave lithotripsy in the third posttransplantation week, and no recurrence of calculi had occurred at the 2-year follow-up.

TABLE 1. Intraoperative and postoperative parameters in right-sided HALDN

Patient No.	Operating time (min)	Delivery time (sec)	WIT (sec)	EBL (ml)	LOS (days)	Cr of donors at discharge (mg/dl)	Cr of recipients on day 28 (mg/dl)	No. of Rt. renal artery/vein	No. of Lt. renal artery/vein	Indication of Rt. HALDN
1	170	124	186	170	4	1.29	1.35	1/1	1/1	A
2	150	147	276	145	5	0.88	1.00	1/1	1/1	B
3	260	132	206	210	4	1.54	1.16	1/1	1/1	A
4	185	119	190	50	4	1.39	1.24	1/1	1/1	A
5	200	137	236	300	4	1.10	0.99	1/1	1/1	A
6	265	121	178	130	4	1.18	1.56	1/1	1/1	A
7	200	135	202	200	4	1.10	1.47	1 ^a /1	2/1	A
8	180	114	242	270	4	0.95	0.94	1/1	1/1	A
9	160	165	245	200	4	1.12	1.23	1/1	1/1	A
10	180	139	184	265	5	0.99	0.92	1/1	1/1	A
11	210	130	200	100	4	0.84	0.93	1/1	1/1	A
12	160	120	170	150	4	1.37	1.20	1/1	1 ^a /1	A
13	170	73	113	300	4	1.22	0.98	2/2	2/1	A
14	210	80	120	290	4	1.23	1.18	1 ^a /1	1/1	A
15	195	120	169	220	4	1.35	1.31	1/1	1/1	A
16	180	100	153	185	5	1.30	1.20	1/1	1/1	A
Mean±SD	192.1±31.6	122.2±22.4	191.8±42.5	199.0±71.4	4.18±0.39	1.17±0.19	1.16±0.18	—	—	—

HALDN: hand-assisted laparoscopic donor nephrectomy, WIT: warm ischemic time, EBL: estimated blood loss, LOS: length of hospital stay, Cr: creatinine, A: difference in split renal function of greater than 10%, B: right renal stone, ^a: single renal artery with an early branching artery that supplied the upper pole of kidney

DISCUSSION

HALDN, which was initially reported by Wolf et al [12], may be the safest option for removing living donor kidneys because the surgeon can use the hand in the surgical field by making an abdominal incision at the start of operation. This digital palpation is a valuable tool that provides surgeons with a tactile sensation that permits them to trace the vascular structures and retract the adjacent structures. Therefore, this technique can minimize intraoperative injury, give immediate management to emergent situations such as bleeding, and especially minimize WIT as compared with pure laparoscopic donor nephrectomy. For these reasons, HALDN has spread quickly and widely, and it has become the method of choice for living donor nephrectomy [13]. Similar to open live donor nephrectomy, most laparoscopic donor nephrectomy procedures have been limited to the left side because of the longer renal vein than on the right side, the greater technical ease of transplantation, and reasonable positioning of the transplanted kidney in the iliac fossa of a recipient [1,2].

However, despite all these advantages of left nephrectomy, not all potential donors have the same situation conducive to left nephrectomy. Conditions do exist in which right donor nephrectomy is preferred. As a typical indication, donors who have significantly lower function in the right kidney than in the left one as determined by DTPA scanning must undergo right nephrectomy to preserve their future renal function [6-10]. Smaller right kidneys and undiagnosed lesions within the right donor kidney are also indications for right donor nephrectomy [14,15]. In addition, some previous studies reported that women at a fertile age who want a future pregnancy must undergo right kidney donation because there is a higher chance of pyelonephritis and hydronephrosis on the right side during the gestational period [7,11]. Much debate has centered on the case of donors with multiple left renal arteries. Some au-

thors recommended that the right kidney should be chosen in such cases [14,15], whereas others report that the presence of renal artery multiplicity does not have a significant impact on the outcomes of the renal donors or recipients when performing LDN [1,3-5]. In our institution, multiplicity of the renal artery is not included in the criteria by which we select the side of the kidney for donor nephrectomy [1].

Until recently, most transplantation centers have hesitated to perform right-sided HALDN and have continued to perform right donor nephrectomy by the open technique [16,17]. The reasons for this choice include a lack of experience, concerns that the shorter length of the right renal vein poses technical challenges for transplant surgeons in transplanting the kidney and thereby increases the risk of intraoperative and postoperative vascular complications in the recipient, and concerns about an increase in delivery time and WIT.

Our technique offers a safe and reliable way to perform right-sided HALDN. There are several key points to mention. Unlike the general method of left-sided HALDN in which a hand port is positioned by making a midline incision just above the umbilicus, our method allows surgeons to stand in the most comfortable position so that they can use both hands most freely by making an abdominal incision for the hand below the umbilicus along the border of the right rectus muscle. We widely mobilized the ascending colon, right transverse colon, and duodenum, and thereby provided a maximal exposure of the right renal hilum and IVC. Furthermore, we gently retracted the right kidney laterally with the help of the surgeon's left hand to extend the right renal vein, and positioned the EndoGIA stapler at the junction of the IVC and right renal vein so that we could achieve a maximal length of the right renal vein. We transected the renal vein by use of the EndoGIA stapler instead of by using Satinsky clamps to reduce the operative time by eliminating the need for intracorporeal

TABLE 2. Comparison of the parameters between the left-sided HALDN and right-sided HALDN groups

	Choi et al [1] Lt. HALDN (n=187)	Chandak et al [19] Lt. HALDN (n=144)	Present study (n=16)
Operative time (min)	193.5±37.3	198±42	192.1±31.6
Delivery time (sec)	109.8±37.3	—	122.2±22.4
WIT (sec)	157.2±72.8	172	191.8±42.5
Estimated blood loss (ml)	431.9±309.2	160	199.0±71.4
Complications (%)	5.3% (10/187)	18.0% (26/144)	0% (0/16)
Intraoperative	1.0% (2/187)	1.3% (2/144)	0% (0/16)
Postoperative	4.3% (8/187)	16.7% (24/144)	0% (0/16)
Length of hospital day (days)	3.9±0.8	3.0	4.18±0.39
Serum Cr (mg/dl) of donors (POD 4 weeks)	1.32±0.66	1.35±0.27	1.15±0.20
Serum Cr (mg/dl) of recipients (POD 4 weeks)	1.29±0.59	—	1.16±0.18

HALDN: hand-assisted laparoscopic donor nephrectomy, WIT: warm ischemic time, Cr: creatinine, POD: postoperative day

suturing. Also, because we believed that the use of the EndoGIA stapler would waste a similar length of vein compared with the use of a Hem-o-lok clip, we used the EndoGIA stapler instead of a Hem-o-lok clip for the renal vein. Ko et al reported an opinion similar to ours regarding this matter [18].

Compared with the surgical outcome of left-sided HALDNs published previously [1,19] (we used the results of 'the single renal artery group' from Choi et al [1]), the 16 right-sided HALDNs in our study showed satisfactory results in not only fundamental surgical parameters such as operative time, EBL, and intraoperative and postoperative complication rates, but also the postoperative serum creatinine level of the recipients, delivery time, and WIT, which are thought to be the most important parameters in kidney transplantation (Table 2). Based on the result that there were no technical problems in the anastomosis of the renal vein in the recipients, we suggest that our technique enabled us to harvest renal veins with appropriate lengths.

There have been several reports on the surgical outcomes of right laparoscopic donor nephrectomy in international journals. Liu et al reported similar surgical outcomes in 19 left-sided HALDNs and 6 right-sided HALDNs [9]. Keller et al reported that 36 right-sided procedures out of 230 LDNs showed similar results in EBL, amount of blood transfusion, operative time, LOS, and delayed graft function compared with left-sided HALDN [20]. There have been more reports about the excellent surgical outcomes of right laparoscopic donor nephrectomy compared with left-sided operations [21-23].

When we reviewed the surgical parameters, mean delivery time and WIT were slightly higher in the right-sided HALDN group than in the left-sided HALDN group. These results seem to be caused by the differences in the operative procedures between the groups. In left-sided HALDN, 2 different ports are simultaneously prepared, 1 for Hem-o-lok (for arterial clamping) and 1 for EndoGIA (for vein stapling). By use of these 2 ports, the renal artery is divided with the Hem-o-lok after the EndoGIA is positioned at the accurate site for renal vein stapling. This technique enables renal vein stapling immediately after renal artery dividing, thereby reducing delivery time and WIT. On the other hand, in right-sided HALDN, only 1 port (C) in addition to a port for liver traction is actually available. Thus, after the renal artery is divided by using a Hem-o-lock instrument and the instrument is removed, we then insert the EndoGIA into the same port, place it in the appropriate position for renal vein stapling, and fire it.

It is conceivable that the anatomically short length of the right renal vein will not always make right-sided HALDN difficult. It is possible for surgeons to obtain an additional length of the right renal vein by performing an *ex vivo* microvascular reconstruction technique (bench surgery) by using the intrarenal vein in right donor nephrectomy [24].

CONCLUSIONS

Right-sided HALDN is safe and technically feasible in donors and shows a favorable graft outcome. The results of this study suggest that right-sided HALDN may be preferable for living donor nephrectomy in patients with significantly lower function in the right kidney than in the left one.

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EDITORIAL COMMENT

This article is a retrospective review of right-sided laparoscopic donor nephrectomy. In the early days of laparoscopic donor nephrectomy, only the left side was procured. Currently, however, owing to advancement in surgical skills, the challenging right side can be harvested as well.

This is the first report in Korea, and I would like to congratulate the authors for overcoming such a difficult task of harvesting the right kidney. There are reports of using clips for longer length (1) and even of single-incision surgery for donor nephrectomy (2), both of which warrant further evaluation.

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