Original Article

Transperitoneal laparoscopic left versus right live donor nephrectomy: Comparison of outcomes

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ABSTRACT

Introduction: Although laparoscopic donor nephrectomy (LDN) is being performed at many centers, there are reservations on the routine use of laparoscopy for harvesting the right kidney due to a perception of technical complexity and increased incidence of allograft failure, renal vein thrombosis and the need for more back-table reconstruction along with increased operative time.

Meterials and Methods: We performed a prospective non-randomized comparison of transperitoneal laparoscopic left donor nephrectomy (LLDN) with laparoscopic right donor nephrectomy (RLDN) from August 2008 to May 2013. The operative time, warm ischemia time, intraoperative events, blood loss and post-operative parameters were recorded. The renal recipient parameters, including post-operative creatinine, episodes of acute tubular necrosis (ATN) and delayed graft function were also recorded.

Results: A total of 188 LDN were performed between August 2008 and May 2013, including 164 LLDN and 24 RLDN. The demographic characteristics between the two groups were comparable. The operative duration was in favor of the right donor group, while warm ischemia time, estimated blood loss and mean length of hospital stay were similar between the two groups. Overall renal functional outcomes were comparable between the two donor groups, while the recipient outcomes including creatinine at discharge were also comparable.

Conclusions: RLDN has a safety profile comparable with LLDN, even in those with complex vascular anatomy, and can be successfully performed by the transperitoneal route with no added morbidity. RLDN requires lesser operative time with comparable morbidity.

Key words: Endo-stapler, IVC cuff, laparoscopic donor nephrectomy, right donor nephrectomy, transperitoneal nephrectomy

INTRODUCTION

Laparoscopic donor nephrectomy (LDN) has the potential to incentivize live organ donation, thus increasing the organ pool for patients requiring renal transplantation.[1] LDN is now the gold standard for graft harvesting.[2,3,4] However, the hurdles for laparoscopy include donors with a suitable kidney on the right side, kidney with complex vascular anatomy like multiple arteries and right renal artery with early branching. Anatomical peculiarities with the right kidney are that the renal vein is shorter and thin walled, and part of the course of the renal artery is behind the inferior vena cava (IVC). Although LDN is being performed at many centers, there are reservations on the routine use for transperitoneal laparoscopic harvesting of the right kidney due to a perception of technical complexity and increased incidence of allograft failure, renal vein thrombosis and the need for more back-table reconstruction along with increased operative time.[5,6] We routinely perform laparoscopic right donor nephrectomy when required and herein compare the outcomes of transperitoneal right versus left donor nephrectomy.

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Access this article online

Quick Response Code:

Website: www.indianjurol.com

DOI: 10.4103/0970-1591.134244

MATERIALS AND METHODS

We performed a prospective non-randomized comparison of transperitoneal left laparoscopic donor nephrectomy (LLDN) with right laparoscopic donor nephrectomy (RLDN) from August 2008 to May 2013.

Criteria for performing RLDN

A right donor nephrectomy was contemplated only when there were two left renal arteries; an early branching left renal artery (<1–1.5 cm from the aorta) and a better functioning left kidney.

A DTPA (Diethylene Triamine Pentacetic acid) renogram was used to assess the split function of the two kidneys. This was correlated with corrected creatinine clearance, calculated from the 24-h urine–creatinine estimation. A better functioning kidney was opined if the difference in glomerular filteration rate was more than 10%.

Left donor nephrectomy

For an LLDN, a conventional four-port technique was used. It started with mobilization of the descending colon, followed by identification of the ureter–gonadal vein complex. The gonadal vein was traced up to the left renal vein. The left adrenal vein was identified, clipped and divided, followed by upper polar dissection, leaving the adrenal gland with the donor. The lumbar vein was clipped and divided in order to facilitate left renal artery exposure and dissection. The kidney was completely mobilized all around, followed by placement of a Pfannensteil incision, stopping short of the peritoneum. Laparoscopically, the ureter, Renal artery and Renal vein were clipped in that order, with a single Hem-o-lock clip each and divided with no clip on the graft side. The kidney was manually retrieved after opening the peritoneum, through the Pfannensteil incision.

Right donor nephrectomy

The port configuration for RLDN was similar to that of the left, with an additional 5 mm port below the Xiphisternum for liver retraction and a 12 mm port in the right end of the Pfannensteil incision for application of the endo-TA stapler [Figure 1a]. The basic steps for RLDN were similar to that of the LLDN. The ureter was dissected separately leaving the gonadal vein alone medially. Once the right renal vein was identified and dissected, the renal artery was identified behind it, traced up to its origin from the aorta by dissecting it posterior to the IVC.

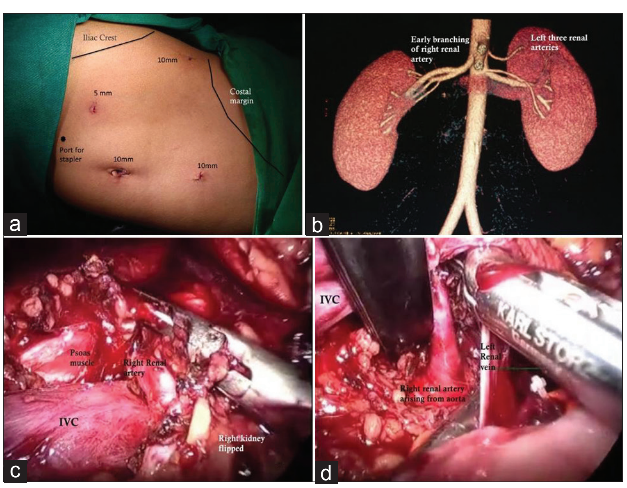

Figure 1: (a) Port configuration for right laparoscopic donor nephrectomy (RLDN). (b) Pre-operative computerized tomography angiogram showing double renal arteries on the left side and early branching right renal artery - for RLDN. (c) Right kidney is flipped after complete mobilization, facilitating renal arterial dissection, especially in those with early branching. (d) Interaortocaval dissection in order to trace the right renal artery to its origin from the aorta

Right renal artery dissection

While the renal artery dissection may be difficult, it can be achieved by completely mobilizing the kidney and flipping the kidney medially and viewing the renal hilum from its posterior aspect [Figure 1c]. The renal artery can be traced directly to its origin from the aorta. In situations where there is early branching of the right renal artery [Figure 1b and 1d], one can approach the artery in the inter-aortocaval space and the renal artery can be traced up to its origin from the aorta thus ensuring a good stump for the artery anastomosis.

Right renal vein division

At this point, the 12 mm port for the endo-TA stapler was inserted. The renal artery was clipped close to its origin from the aorta, retracting the IVC. The endo-TA stapler with 30 mm reload was applied on the IVC in such a way as to get a cuff of IVC along with the right renal vein stump [Figure 2a and b]. The three rows of staggered clips were applied on the side of the IVC [Figure 2c and d], while the IVC wall on the renal vein side was cut flush with the staple line and the kidney extracted manually through the Pfannensteil incision.

LDN was performed by a single surgeon. The operative time, warm ischemia time, intraoperative events, blood loss and post-operative parameters were recorded. The renal recipient parameters including post-operative creatinine, episodes of ATN and delayed graft function were also recorded. An informed consent was obtained from all the donors.

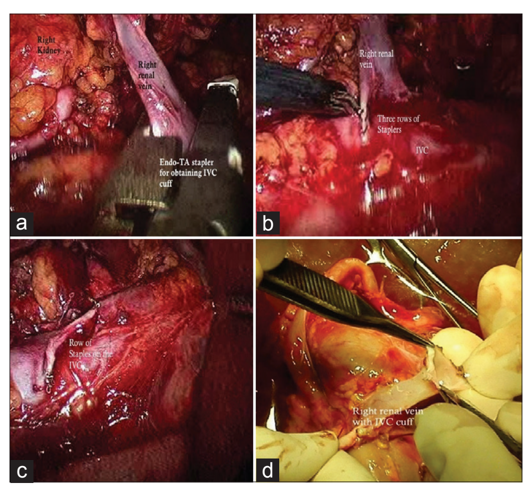

Figure 2: (a) Endo-TA Stapler application on the IVC wall abutting the right renal vein, with gentle traction on it, (b) Three rows of staples on the IVC wall before renal vein division, (c)IVC wall with staples, at the site of the renal vein stump, (d)Right renal vein in the graft with the thick IVC cuff

Statistical analysis was carried out using the Students t test and the Chi-square test, with a *P* value of less than 0.05 being taken as significant.

RESULTS

A total of 188 LDN were performed between August 2008 and May 2013, including 164 LLDN and 24 RLDN. The demographic characteristics of both groups were comparable, except the pre-operative creatinine [Table 1]. The right kidney donors' average creatinine was significantly higher than the left kidney donors (0.81 vs. 0.74, $P = 0.04$), although both lie within the normal laboratory range. Among the 24 RLDN, 20 patients had a single renal artery whereas two patients had two renal arteries. Two patients had early branching of the main renal artery (1.0-1.5 cm from the aorta). The endo-TA stapler was successfully applied in 18 cases. In four patients, the renal vein was ligated using a single Hem-o-lok clip. The operative duration was in favor of the right donor group (164.84 min left vs. 134.04 min right, $P = 0.004$), while warm ischemia time, estimated blood loss and mean length of hospital stay were similar between the two groups (3.2 min vs. 4.08 min, $P = 0.03$; 154 mL vs. 149 mL, $P = 0.12$; 5.61 days vs. 5.54 days, $P = 0.11$). The measured lengths of the graft vessels were also comparable between the two groups [Table 1].

Among the complications, the most common was respiratory morbidity (11 in LLDN vs. 2 in RLDN, $P = 0.76$), varying from lower lung consolidation to minimal pleural effusion to empyema requiring ICD drainage [Table 2]. Post-operative pyrexia was observed in eight patients in the LLDN group and one patient in the RLDN group ($P = 0.87$).

There were two significant vascular complications in the LLDN group, both resulting in conversion to open technique. In the first case, the injury was to the renal artery while traction was being given to the kidney just before retrieval, which was later determined to be due to thermal injury caused by the harmonic scalpel during the initial part of hilar dissection. The bleeding renal arterial stump was immediately compressed with a laparoscopic suction device and the graft was retrieved by a flank incision. However, the warm ischemia time was 8 minutes and the donor did not require any blood transfusion post-operatively. The second case was an inadvertent division of the superior mesenteric artery (SMA), which was temporarily brought under control like the first case. The renal graft was retrieved and taken for transplantation, while the SMA was re-anastamosed to the aorta with the use of a 5 cm Dacron vascular graft with the help of a vascular surgeon. The donor required 4 units of packed cell transfusion post-operatively and resumed bowel functions by the 5th day. The donor had normal renal function, normal hemogram and normal bowel activity at 1 year of follow-up. Including these conversions, there were in total four conversions in the LLDN group and one conversion in the RLDN group. The other case in LLDN was due to mesenteric injury during port insertion. The case of RLDN that was converted, was due to a broad and short right renal vein obscuring the renal artery identification and dissection.

There were a few minor complications like accidental cystotomy in one patient (left kidney donor) while performing Pfannensteil incision for specimen retrieval

Table 1: Patient demographics and intra-operative and post-operative variables

	Range (mean)		*P* value
	LLDN, (*n*=164)	RLDN, (*n*=24)	
Male/female	33/131	08/16	-
Age (years)	23-67 (43.04)	25-58 (38.05)	0.96
BMI	21.1-33.2 (26.14)	21.3-32.1 (25.08)	0.34
Pre-op creatinine	0.6-1.2 (mean, 0.74)	0.7-1.2 (mean, 0.81)	0.04
Estimated blood loss, mL	100-1200 (154)	100-500 (149)	0.12
Duration of surgery, min	132-226 (164.84)	121-181 (134.04)	0.004
Length of renal artery, cm	2.5-3.6 (3.12)	2.4-3.4 (3.07)	0.09
Length of renal vein, cm	2.44-3.45 (3.18)	2.43-3.34 (2.99)	0.03
Warm ischemia time, min	2.8-4.2 (3.2)	3.1-5.5 (4.08)	0.03
Hospital stay, days	3.3-10.2 (5.61)	3.7-7.3 (5.54)	0.11
Creatinine at discharge, mg/dL	0.8-1.6 (1.18)	0.9-1.5 (1.29)	0.03

BMI = Body mass index, LLDN = Left donor nephrectomy, RLDN = Right donor nephrectomy

Table 2: Donor and recipient complications

	LLDN (*n*=164)	RLDN (*n*=24)	*P* value	Modified clavien classification grade*[29]
Donor complications				
Atelectasis	6	1		1
Consolidation	4	1		1
Empyema	1	-		2 (0.6%)
Post-op pyrexia	8	1	0.87	1
Vascular	2	0	-	
Renal artery injury	1	-		2 (0.6%)
SMA injury	1	-		2 (0.6%)
Conversion	4	1	0.62	2 (2.8%)
Seroma	1	0	-	1
Cystotomy	1	0	-	2 (0.6%)
Recipient complications				
Acute rejection	15	03	0.60	N.A.
Slow+delayed graft function	26	02	0.33	N.A.
Graft loss	3	1	-	N.A.
Recipient creatinine at discharge, mg/dL	1.23	1.22	0.44	N.A.

*Kocak *et al.*[29] N.A. = Not applicable, LLDN = Left donor nephrectomy, RLDN = Right donor nephrectomy that was closed subsequently. One of the left kidney donors had a seroma at the operated site.

Renal functional outcomes were comparable between the two groups. While the donor creatinine at discharge was significantly higher for the right side group, both were in the normal range (1.29 vs. 1.18).

Recipient outcomes including the creatinine at discharge were also comparable between the two groups [Table 2]. No difficulty was experienced in the recipient anastomosis. Three grafts were lost in recipients of left-sided kidney donors, while only one was with those from right-sided kidney donors. Causes of graft loss included chronic allograft nephropathy and graft vein thrombosis.

DISCUSSION

Since the first reports on feasibility of laparoscopic technique for donor nephrectomy, there are overwhelming reports demonstrating that LDN when compared with open donor nephrectomy (ODN) results in similar graft and patient survival, similar urological complications, but more favorable analgesic requirements, pain data, hospital stay and time to return to work.[7,8,2,9,10]

With the growing literature on LDN, it is notable that these are reports predominantly on left LDN. Anatomically, the right renal vein is short and thin walled and the right renal artery has a retrocaval course. There are a few studies reporting on RLDN comparing with that of LLDN, with reports of increased operation room time, hospital stay and increased allograft failure with RLDN.[11,5] Kay and others report that although RLDN is faster and easier, there is a significantly greater need for back-table reconstruction after the graft is harvested [Table 3].[6]

Various techniques have been described to overcome this anatomical challenge associated with RLDN. Grafts with short renal vein (<1.5 cm) are tackled by placing the kidney upside down during transplantation, with no increased incidence of vascular thrombosis with this modification.[12] There are reports demonstrating the use of Endo-GIA staplers. We feel that the disadvantage with the use of an Endo-GIA stapler application is that it also fires staples on the side of the renal vein that needs to be excised, which further compromises the renal vein length. Ko and others have reported the use of staplers for both LLDN and RLDN to maximize vessel length, while Bollens *et al.* recommend removing the triple staggered rows of staplers applied on the graft side before transplantation in order to maximize the vessel length.[13,14] On the other hand, Liu *et al.* document the use of non-absorbable ligating polymer (NLP) clips that would lessen the cost of the procedure and are less prone to malfunction when compared with that of the stapler.[15,16]

In our series, the right renal arterial length has been taken care of by a complete retrocaval dissection, while sometimes resorting into interaortocaval dissection. The Endo-TA stapler for the right renal vein with an IVC cuff gives maximum length, along with the thick IVC wall for more secure suturing at the venous anastomosis site during transplantation. We have not encountered the need for any back-table surgery on the right-sided kidney grafts. While a few authors have demonstrated that complex right renal vascular anatomy is not a contraindication to RLDN, others have suggested modification such as the use of saphenous vein patch for renal vein reconstruction and the use of the retroperitoneoscopic approach for obtaining maximum arterial length.[17,18-21] As some studies have demonstrated that RLDN is faster, with quicker convalescence, shorter OR time and lesser blood loss, RLDN has to be encouraged to extend the advantages of minimally invasive surgery to a greater donor pool.[22-24]

While some question the safety issue with the use of single Hem-o-lock® clip for the renal artery, the issue has been adequately addressed in the literature – that the completeness of clip application and amount of tissue left between clip and point of division are more important than the angle or number of clips.[25-27] *In vitro* studies show that burst pressures required for a Hem-o-lock clip are

Table 3: Comparative studies

	No. of patients (*N*) (L, R)	Warm ischemia	Operative duration (min)	Blood loss (mL)	Donor complications	Hospital stay (days)	Renal artery length (mm)	Renal vein length (mm)
Dols LF[23]	124-L	-	247	294	6%	3.12	-	-
	156-R	-	202	139	19%	3.23	-	-
Ruszat R[13]	98-L	NS	NS	NS	NS	NS	-	-
	28-R							
Kay MD[6]	66-L	-	182	NS	NS	NS	38	32
	18-R	-	132				27	31
Lind MY[18]	101-L		282	NS	NS	NS	-	-
	73-R		218				-	-
Saad S[19]	48-L 25-R	NS	NS	NS	NS	NS	-	-

NS = Not studied, L = Left, R = Right

supra-physiological.[27] However, it is to be noted that the manufacturers do not recommend the use of Hem-o-lock in donor nephrectomy.

Another notable advantage of the RLDN is that it requires lesser operative time as there is no need for ligation of the gonadal vein, adrenal vein and lumbar vein, unlike that in LLDN. In cases of high origin of right renal artery, the dissection was performed superior to the renal vein by simply retracting the vein inferiorly. In cases with early branching of the right renal artery where the IVC retraction would not give easy access to the trunk of the right renal artery, it was approached with an inter-aortocaval dissection [Figure 1d]. The right kidney donors' pre-operative creatinine being higher may not be of any significance in our study and did not matter as both the groups average post-operative creatinine were also in the normal range.

CONCLUSION

RLDN has a safety profile comparable with the LLDN even in patients with a complex vascular anatomy and can be successfully performed by the transperitoneal route with no added morbidity. RLDN requires lesser operative time, comparable warm ischemia, estimated blood loss and hospital stay compared with LLDN. Post-operative donor and recipient renal function is comparable in both LLDN and RLDN groups.

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How to cite this article: Pandarinath SR, Choudhary B, Chouhan HS, Rudramani S, Dubey D. Transperitoneal laparoscopic left versus right live donor nephrectomy: Comparison of outcomes. Indian J Urol 2014;30:256-60.

Source of Support: Nil, **Conflict of Interest:** None declared.