Original Article

Urology, Nephrology and Andrology International
Volume 6 Number 1, January - June 2021
DOI: http://dx.doi.org/10.21088/unai.2456-5016.6121.1

Author's Affiliation:
Assistant Professor,
Department of Urology,
Adichunchanagiri Institute of Medical Sciences,
B G Nagara, Nagamangala, Mandya 571448
Karnataka, India.

Corresponding Author: Dr Vikram H N
Assistant Professor, Department of Urology,
Adichunchanagiri Institute of Medical Sciences,
B G Nagara, Nagamangala Mandya, 571448
Karnataka, India.

Email: drvikramhn@gmail.com

Laparoscopic Live Donor Nephrectomy: The Future Gold Standard?

Vikram H N[1]

Abstract

End stage renal disease (ESRD) has been a long-standing challenge for the community. Renal transplantation being the mainstay treatment reaches only about 5% of the patients due to supply demand mismatch. Open donor nephrectomy (ODN) is the common method of renal allograft harvest. Since it is associated with significant morbidity, the less invasive laparoscopic donor nephrectomy (LDN) is gaining importance. ***Objectives:*** This study attempts to compare a group of donors undergoing LDN to those undergoing ODN in terms of factors like operating time, blood loss, conversion rates, hospital stay, complications, post-operative donor renal function along with assessment of graft function. ***Methods:*** A prospective non randomized study was conducted on 58 live donors who consented to donate kidney for renal transplantation at Meenakshi Mission Hospital and Research Centre, India. They were compared for intra-operative variables, postoperative complications, post-operative donor function and recipient renal function thereby assessing the graft function. The donors and recipients were followed for a period of 1 year to assess their renal function, occurrence of any new co-morbid conditions, recipients' graft function. Continuous variables were analyzed using Student's t-test while categorical variables were compared using the chi square test. 'α' value was set at 0.05. ***Results:*** Of the 58 patients, LDN was done in 28 patients with two undergoing conversion. The mean operation duration and warm ischemia time for LDN and ODN groups were similar. The length of hospital stay was significantly shorter in LDN group. There were no major complications nor was there any significant differences in the post-operative donor/recipient renal function as well. ***Conclusion:*** LDN can evidently be performed with less morbidity, better donor satisfaction and equivalent initial graft function.

Keywords: Open donor nephrectomy; Laparoscopic donor nephrectomy; Kidney transplantation; End stage renal disease; Donor outcome transplantation; End stage renal disease; Donor outcome.

How to cite this article:
Vikram H N/ Laparoscopic Live Donor Nephrectomy –The Future Gold Standard?./ Urology, Nephrology and Andrology International. 2021;6(1):7-12.

Introduction

"*End-Stage Renal Disease has been a long-standing challenge for the community. It's never raised itself in terms of volume of patients to be a huge need, but it's really an incredible inconvenience for the patients and their families*."

ESRD continues to be a major medical concern across the world. Renal transplantation (RT) remains the mainstay and cost-effective therapy for these patients. Although it is the best option, only about 5% of them end up having a transplant as the supply of organ is greatly exceeded by demand. Currently, open donor nephrectomy (ODN) via flank approach is the most common method of live

donor renal allograft harvest but has significant morbidity like infection, hernia, pneumothorax and extended convalescence. Hence, the less invasive laparoscopic donor nephrectomy (LDN) is gaining more popularity which is a less morbid procedure but has a steep learning curve. It is even helping to increase the frequency of donation thus increasing the pool of renal donors[1]. Living donor nephrectomy is basically a distinctive surgery because of a healthy persons' willingness to undergo a surgery with significant risk to herself as to why the donor satisfaction in terms of minimal morbidity and safety is utmost important. LDN is associated with less postoperative pain, shorter hospitalization, less incisional complications, early return-to-normal activity. Importantly, no significant differences have been observed in creatinine clearance or allograft survival rates when comparing the recipient outcomes. Ratner et al performed the first LDN in the year 1995[2] and with many centers around the world performing this procedure, a 25% increase in donations has been reportedly attributed to this approach[3]. This study attempts to compare a group of patients undergoing LDN and ODN in terms of donor outcome with factors like operating time, blood loss, hospital stay, complications and alterations in donor renal function and recipient outcome.

Material and methods

A prospective non randomized study was conducted on live donors who had consented to donate kidney for RT. The study was conducted at Meenakshi Mission Hospital and Research Centre, India for a period of 1 year. A total of fifty-eight patients meeting the criteria of renal donors were included in the study on the basis of purposive sampling technique. The study was approved by the Research Ethics Committee and informed consent was obtained. The two groups were matched for age and gender. Donors included in the study were those with body mass index (BMI) <28 kg/m^2, with no complexity in the donor renal vessels.

Pre-operative investigations included a 3D abdominal CT urogram to understand the renal anatomy and vasculature, DTPA scan to assess the glomerular filtration rate (GFR), abdominal ultrasonography, immunologic and cardiology studies. The better functioning kidney was left behind depending upon the GFR. All donors were evaluated by a psychiatrist for their state of mind to ensure there is a positive attitude towards donation. Transplant committee meetings were held prior to each RT. Of the 58 donors, 30 underwent ODN while LDN was performed in 28 donors. Adequate hydration was maintained using crystalloids and mannitol was used for diuresis. During induction, a dose of cefaperazone/amoxicillin/clavulunate was administered. Fentanyl pain-pump was used post-operatively according to pain scale. Serum creatinine levels were measured serially in recipients and donors.All donors were then followed on a 3-monthly basis for assessing their renal function.

ODN was done by standard retroperitoneal approach. Under general anesthesia (GA), with flank position an eleventh rib cutting transcostal incision was taken and deepened. After reflecting the peritoneum, Gerota's fascia was opened and the kidney was dissected. The renal vessels were carefully dissected up to their origins. The ureter was also dissected up to iliac vessel crossing and divided taking care on its vascularity. This was followed by ligation and division of renal vessels. The kidney was extracted and handed over for perfusion. Hemostasis was checked and abdominal wall was closed. For LDN, under GA, patient was placed in lateral position. Primary port (10 mm) was placed at the umbilicus and pneumoperitoneum was created followed by placement of working ports. Procedure began with reflection of the left colon by dissecting along the line of Toldt followed by division of splenorenal and splenocolic ligaments. Once the lower pole of the kidney was identified, dissection of the ureter was done up to iliac bifurcation taking care to preserve the adventitia. After the mobilization of kidney, the hilar dissection was done followed by clipping of left adrenal vein, gonadal vein and lumbar veins. Most of the dissection was done using harmonic scalpel. Iliac fossa extraction incision was made and muscles divided without opening the peritoneum. The ureter was clipped and divided. The renal vessels were clipped using Hem-O-Lok (Weck) and divided. Once the kidney was free, peritoneum was opened and kidney retrieved and handed over for perfusion. Port and extraction incision closure was done.

Patient data were obtained by prospective database, medical record review, and personal interviews. Continuous variables were expressed as percentages, means ± standard deviation and were analyzed using Student's t-test. Categorical variables were compared using the chi square test. A 'p' value less than 0.05 was taken to denote significant relationship.

Results

Of the 58 donors, 30 underwent ODN and 28 had LDN. In both groups there were more female donors (Table 1). The average age was about 44.6+10.59 yrs and 35.7+6.41 yrs in open and laparoscopic group respectively. All 28 LDN were performed only on left kidneys because of surgeons' preference. Among those who had ODN, right nephrectomy was done in 27 donors and 3 donors had segmental polar vessels on the left side, hence had ODN. The right kidney was chosen if there were multiple left renal vessels or for presence of benign pathology in the right kidney. The basic principle of leaving the better kidney with the donor was always adhered to.

Table 1: Group Composition.

Group	Sex				
	Male		Female		Total
	No	%	No	%	No
Open Donor Nephrectomy	10	33.3	20	66.7	30
Laparoscopic Donor Nephrectomy	3	10.7	25	89.3	28
Total	**13**	**22.4**	**45**	**77.6**	**58**

The average number of hospital days was significantly lesser among LDN group which was 6.9+1.27 days while it was 8+2.1 days in ODN group (Table 2). Majority of donors were from distant towns and wanted the discharge along with recipients in both the groups in order to avoid the travel separately.

Table 2: Number of Hospital Days.

	Hospital Days Range	Hospital Days Average	Standard Deviation
ODN	5-14	8	2.1
LDN	5-9	6.9	1.27
p Value	0.0153311		

On an average the mean operative time (table3) for those who underwent ODN was 117.2+14.10 minutes while it was 113.75+17.61 minutes for those who underwent LDN. The duration of surgery in laparoscopy group gradually decreased with better surgical experience indicating the importance of learning curve. With respect to warm ischemia time (WIT) which influences the graft function, it was 2.36+0.48 minutes in the ODN group and 2.5+0.42 minutes in LDN group which was not significant (Table 3).

Table 3: Operative Time And Warm Ischemia Time.

Parameter	Operative time (In minutes)		Warm Ischemia Time (In minutes)	
	ODN	LDN	ODN	LDN
Range	90-140	90-160	1.5-4	2-3.3
Mean	117.2	113.75	2.36	2.5
SD	14.10	17.61	0.48	0.42
'p'	0.411		0.345	

Two patients of LDN (7.14%) required conversion to open nephrectomy. In one donor there was intraoperative hemorrhage due to gonadal vein avulsion. After conversion, bleeding was controlled and she required two units of blood transfusion. In another patient, there was slippage of the lumbar vein clip as to why immediate laparotomy was done and bleeding was controlled. This patient however did not require any transfusion. No donors underwent re-operation/ re-exploration.

The mean fall in the hemoglobin between the two groups (Table 4) suggested that there is no significant difference in the fall. One patient in the ODN group needed to be transfused with 2 units of packed red blood cells in view due to lumbar vein tear. While in the LDN group, a total of 4 donors had to be transfused. 2 had marginal fall in hemoglobin post-operatively. One donor had significant fall due to intraoperative hemorrhage because of lumbar vein tear while the other had avulsion of gonadal vein as to why he was also converted to open nephrectomy.

Table 4: Fall In Haemoglobin – Donor.

Hemoglobin in gm/dl	Hemoglobin (Donor) Mean +SD		'p'
	ODN	LDN	
Pre-operative Hb	12.82 +1.72	11.85 +1.04	0.247
Post-operative Hb	10.93 +1.81	10.29 +1.34	
Fall in Hb	1.89 +1.01	1.56 + 1.08	

Table 5: Complications in Donors.

Complications in Donors	Cases with complications in			
	Open nephrectomy		Laparoscopic nephrectomy	
	No	%	No	%
Adrenal hemorrhage	1	3.3	1	3.5
Acute tubular necrosis	1	3.3	-	-
Intra operative bleed	2	6.6	3	10.7

In terms of complications, (table 5) more were observed in the ODN group, commonest being pleural tear which was repaired with no

requirement of intercostal drainage. Intraoperative hemorrhage occurred in 2(6.6%) patients in ODN group, one had lumbar vein tear while another had adrenal vein tear. In the laparoscopic group, intraoperative hemorrhage occurred in three donors due to gonadal vein avulsion and lumbar vein tear. No complications such as surgical site infections, urinary tract/ respiratory infections or deep vein thrombosis were observed in either of the groups. One in the LDN group had adrenal hemorrhage for which laparoscopic adrenalectomy was done. One in the ODN group had acute tubular necrosis which was managed and the patient was discharged with a stable serum creatinine of 2 mg/ dl. In either group, there was no mortality nor re-explorations. Two in the ODN group developed acute tubular necrosis and had a stable creatinine of 2 mg/dl at discharge (Table 6).

Table 6: Post Operative Serum Creatinine Changes in Donors.

Serum creatinine valued in donor	Serum creatinine (Mean+SD)		'p'
	ODN	LDN	
Pre-operative	0.77 +0.15	0.68 +0.23	
Post-operative – Day 30	1.23 +0.29	1.07 +0.30	0.055
Post – operative Day 90	1.17 +0.28	1.10 +0.25	0.359

Taking recipient outcome into account, the fall in serum creatinine was much slower on day one in LDN group in comparison to ODN group. However, the fall was similar from day three onwards. Hence, though the fall in serum creatinine was much slower initially in LDN group, changes were insignificant later (Table 7)

Table 7: Post-Operative Serum Creatinine Changes in Recipients.

Serum creatinine (Recipient)	Serum creatinine value in recipients (Mean+SD)		'p'
	Open nephrectomy	Laparoscopic nephrectomy	
Pre-operative	5.62 +1.45	6.29 +1.62	
Post-operative Day 1	2.58 +0.88	3.19 +1.00	0.017
Month 1	1.26 +0.36	1.41 +0.40	0.161
Month 3	1.09+0.27	1.18 +0.30	0.197
Month 6	1.11 +0.28	1.20 +0.28	0.381

Discussion

This study was carried out to understand the donor outcome with factors like operating time, blood loss, conversion rates, hospital stay, complications and alterations in donor renal function along with assessment of graft survival in those undergoing ODN and LDN. The percentage of donors was predominated by females to a larger extent of 77.6%. This could raise questions in developing countries like India if social circumstances force the women in the family to donate organs apart from emotional reasons. The sex ratio seen is in contrast to the group enrolled under Simforoosh et al[4] wherein males accounted for 89% of the donors.

Reviewing the study results, no statistical differences were made out of the operative time, warm ischemia time, fall in the hemoglobin between the two groups. The complications were much lesser in LDN group and were of vascular in nature. There was no re-exploration nor mortalities in either group. With reference to donor renal function though there were no significant differences, two patients in ODN group were discharged with a creatinine of 2 mg/dl. This has a bearing on the donor in terms of labelling them into a status of CKD. Majority of the studies might under report such findings which get masked when statistical analysis is being carried out.

Patients with appropriate renal vascular anatomy and those who were planned for left nephrectomy as per their GFR were the ones chosen for LDN. The right kidney was always chosen for ODN along with left kidneys with multiple arteries or shorter veins. Many studies have not reported the side of LDN, Kanashiro et al[5] have reported that all of their LDNs were of the left side because of the surgeons' preference. Though the LDNs initially were carried out only on the left side in view of the short right renal vein, nowadays right LDN is being carried out. Endo-TA staplers have been recommended which gives additional length to the right renal vein for anastomosis thus reducing complications like venous thrombosis.[6]

In the initial years, the operating time was significantly longer for LDN. In our study too, the mean operating time for LDN is about four minutes longer than ODN. Flowers et al[7] and Leventhal et al[8] also reported a longer mean operating time for LDN by about 13 and 90 minutes respectively. However, with better experience and modification in the technique, LDN can be completed much earlier by about 30 minutes as shown by Manohar et al.[9]

The mean warm ischemia time (WIT) was just about fourteen seconds longer in laparoscopic group as compared to open group. In a report by Kanashiro et al[5], the WIT was 85.95±23.55 seconds for laparoscopic group and was 250.21±55.82

seconds which was significant. However, no clinically demonstrated negative effect is noted on kidney function if the WIT is less than 10 minutes, which is the case in almost all laparoscopic series.[10]

The conversion rate in our study was 7.14% as comparable to that reported in literature.[11] The reasons for conversion were due to lumbar vein clip slippage and gonadal vein avulsion. Srivastava et al [12] reported 12 (n=342) conversions wherein the commonest cause was bleeding which occurred in 6 patients while in other 4 patients, it was difficult to proceed due to adhesions. Two of their patients also had bowel injury as to why conversion was needed. Flowers[7] reported four patients (6%) requiring conversion to laparotomy, three for vascular injury and one for a combination of morbid obesity and inability to sustain pneumoperitoneum. In our study, no re-operation was carried out in either of the groups in contrast to those reported in Kanashiro[5]. In their study, two patients in the open group required re-operation due to bleeding of the gonadal vein and one was re-operated in the laparoscopic group due to bleeding of the gonadal vein (conversion needed) and the other was re-operated due to a pancreatic fistula. Re-operation was also needed in a study by Flowers[7] due to splenic injury. No mortality was there in either of the groups in our study.

The mean fall in hemoglobin was 1.89+1.01 gm/dl in open group and was 1.56+1.08` gm/ dl in laparoscopic group. In contrast, Simforoosh[4] reported a hematocrit difference of 3.7% and 4.1% in the open and laparoscopic group respectively. On the other hand, similar to our study Manohar[9] reported a lesser fall in hematocrit in laparoscopic group which was about 4.12% and 3.4% in the ODN group. The blood loss usually is much less in laparoscopic group compared to open donor nephrectomy group as shown by Sasaki[13].

The perioperative mortality rate of living donor nephrectomy ranges between 0.02% and 0.04% and morbidity rate goes from 8% to 18%. Overall complications were about 13.2% in the open group and 14.2% in the laparoscopic group in our study. The commonest complication in the open group was pleural tear (26.2%) which was repaired. This was also the common complication in Flowers[7] series which accounted for 22% among open donors. The serious complications seen were intraoperative hemorrhage and acute tubular necrosis in the open group. The common complication seen in laparoscopic group was splenic laceration in the Simforoosh[4] study whereas it was intra-operative hemorrhage in the Flowers[7] study. In our study, intra-operative hemorrhage due to gonadal vein avulsion, lumbar vein clip slippage and adrenal laceration occurred. There were no bowel injuries in our study; it was seen in the series by Srivastava et al[12] and Simforoosh et al[4]. Complications involving ureter, major vessels, splenic injuries, port site injuries were not seen in our series. There were no mortalities either in our study.

The total hospital days ranged from 5-14 days in open group and 5-9 days in laparoscopic group which is longer in both groups in contrast to several studies in the literature. Srivastava et al[12] reported a mean hospital day of 5.7 days for open group and 3.14 days for laparoscopic group. Longer stay in our study in both the groups was because the donors wanted to get discharged along with their respective recipients. This has been taken care by providing quarters outside the hospital to prevent nosocomial infections. Most of the studies have concluded as having a shorter hospital stay and early convalescence in the laparoscopic group.

There was a rise in mean serum creatinine post-operatively in both open and laparoscopic donors. However, very few studies have reported the behavior of the renal function post-operatively in donors. A study by Muzaale et al[14] comparing a cohort of 96,217 donors to 20,024 healthy non donors over a period of 17 years, observed that the estimated risk of ESRD at 15 years after donation was 30.8 per 10,000 among donors and 3.9 per 10 000 in their matched healthy non-donor counterparts (P <.001).

The recipient outcome in both open and laparoscopic groups was similar. In a study by Kanashiro et al[5], the mean serum creatinine in recipients of open group was 1.97±2.07 mg/dl and it was 1.49 ± 1.38 mg/dl in laparoscopic group on post-operative day ten. In a series by Simforoosh et al[4], delayed graft function was diagnosed in eight patients in the open and eleven in the laparoscopic group. They reported a long-term graft survival was 93.8% in the laparoscopic group and 92.7% in the open group. The incidence of acute tubular necrosis after living related kidney donation ranges from 1% to 6% and is thought to be an ischemic event. In a systematic review of 24 comparative studies for both open and laparoscopic group, the trend was for values to start at approximately 4.0 to 5.0 mg/dl on post-operative day 1 but to drop to approximately 1.5 by post-operative day 7 and to stabilize at approximately that level thereafter.[4]

Limitation of the study: Postoperative pain, analgesia, quality of life of the donors like timing of return to activities were not evaluated. Long term

donor follow up was lacking for the assessment of their renal function which plays a crucial role.

Conclusion

Laparoscopic donor nephrectomy can be performed safely with less morbidity, better donor satisfaction and equivalent graft function. With better learning experience, it can be performed in fact with shorter operative and warm ischemia time. Done in a meticulous manner, it has less complication rates and better post-operative recovery with no bearing on recipient outcome. Keeping social issues in mind, it is necessary that proper counselling is given so that both men and women come forward for organ donation. LDN may thus help in increasing the total number of live-related kidney transplants. With all these advantages, LDN might become the gold standard of live donor renal allograft harvest in the future.

References

1. Leventhal JR, Kocak B, Salvalaggio PR, Koffron AJ, Baker TB, Kaufman DB, Fryer JP, Abecassis MM, Stuart FP. Laparoscopic donor nephrectomy 1997 to 2003: lessons learned with 500 cases at a single institution. Surgery 2004; 136: 881-890 [PMID: 15467675 DOI: 10.1016/j.surg.2004.06.025]
2. Ratner LE, Ciseck LJ, Moore RG, Cigarroa FG, Kaufman HS, Kavoussi LR. Laparoscopic live donor nephrectomy. Transplantation. 1995;60(9):1047-9.
3. RatnerLE, MontgomeryRA,KavoussiLR.Laparos copiclivedonornephrectomy: the four-year Johns Hopkins University experience. Nephrol Dial Transplant. 1999;14(9):2090-3.
4. Simforoosh N, Basiri A, Tabibi A, Shakhssalim N, Hosseini Moghaddam SM. Comparison of laparoscopic and open donor nephrectomy: a randomized controlled trial. Br J Urol Int. 2005; 95(6):851-5.
5. Kanashiro H, Lopes RI, Saito FA, et al. Comparison between laparoscopic and subcostal mini-incision for live donor nephrectomy. Einstein. 2010; 8(4):456-60.
6. Berney T, Malaise J, Mourad M, Morel P, Squifflet J-P. Laparoscopic and open live donor nephrectomy: a cost/benefit study. Transplant Int. 2000; 13:35-400.
7. Flowers JL, Jacobs S, Morton A, et al. Comparison of open and laparoscopic live donor nephrectomy. Ann of Surg. 1997; 226(4): 483-90.
8. Leventhal JR, Deeik RK, Joehl RJ, et al. Laparoscopic live donor nephrectomy-is it safe? Transplant. 2000; 70(4):602-606.
9. Manohar T, Wani K, Gupta R, Desai MR. Risk reduction strategies in laparoscopic donor nephrectomy; a comparative study. Indian J Urol. 2006 sept; 22: 201-4.
10. Simforoosh N, Basiri A, Shakhssalim N, Ziaee SA, Tabibi A, Moghaddam SM. Effect of warm ischemia on graft outcome in laparoscopic donor nephrectomy. J Endourol. 2006; 20(11):895-8.
11. Nanidis TG, Antcliffe D, Kokkinos C, et al. Laparoscopic versus open live donor nephrectomy in renal transplantation: a meta-analysis. Ann Surg. 2008; 247(1):58-70.
12. Srivastava A,Gupta N,Kumar A, Kapoor R, Dubey D. Transperitoneal laparoscopic live donor nephrectomy: Current status. Indian J Urol. 2007 Jul–Sep; 23(3): 294–298.
13. Sasaki TM, Finelli F, Bugarin E, et al. Is laparoscopic donor nephrectomy the new criterion standard? Arch Surg. 2000; 135:943-947.
14. Abimereki D. Muzaale, Allan B. Massie,Mei-Cheng Wang, et al. Risk of End-Stage Renal Disease Following Live Kidney Donation. JAMA. 2014 Feb; 311(6): 579-586.