Back-to-back comparison of mini-open vs. laparoscopic technique for living kidney donation

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Cite as: *Can Urol Assoc J* 2016;10(7-8):253-7. http://dx.doi.org/10.5489/cuaj.3725

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Abstract

Introduction: Laparoscopic living donor nephrectomy is the standard of care at high-volume renal transplant centres, with benefits over the open approach well-documented in the literature. Herein, we present a retrospective analysis of our single-institution donor nephrectomy series comparing the mini-open donor nephrectomy (mini-ODN) to the laparoscopic donor nephrectomy (LDN) with regards to operative, donor, and recipient outcomes.

Methods: From 2007–2011, there were 89 cases of mini-ODN, at which point our centre transitioned to LDN; 94 cases were performed from 2011–2014. In total, 366 patients were reviewed, including donor and recipient pairs. Donor and recipient demographics, intraoperative data, postoperative donor recovery, recipient graft outcomes, and financial cost were assessed comparing the surgical approaches.

Results: We demonstrate a reduced estimated blood loss (347.83 vs. 90.3 cc), lower intraoperative complication rate (4 vs. 11) and shorter length of hospital stay (2.4 vs. 3.3 days) for patients in the LDN group. Operative time was significantly longer for the LDN group (108.4 vs. 165.9 minutes), although this did not translate to a longer warm ischemia time (mean 2.0 minutes for each group). The rate of delayed graft function and recipient 12-month creatinine were comparable for ODN and LND. Overall cost of LDN was $684 higher for an uncomplicated admission.

Conclusions: Despite a longer surgical time and higher upfront cost, our study supports that LDN yields several advantages over the mini-ODN, with a lower estimated blood loss, fewer intraoperative complications, and shorter length of hospital stay, all while maintaining excellent renal allograft outcomes.

Introduction

End-stage renal disease (ESRD) is a prominent and growing concern in Canadian healthcare. Each year, over 5000 new cases of ESRD are reported, adding to the already pre-existing pool of 42 000 people living with this condition.[1] Treatment of ESRD is very costly, with one year of hemodialysis costing approximately one million dollars per patient. The gold standard treatment for ESRD is renal transplantation, with approximately 1400–1500 kidneys being transplanted in Canada each year.[1,2] Living donor nephrectomy was first introduced 50 years ago.[3] Since then, numerous studies have shown superior outcomes over deceased donor nephrectomy with regards to long-term patient and graft survival.[4] A number of surgical techniques have been developed to minimize morbidity for donors, while maintaining optimal function of transplanted kidneys for recipients.

Laparoscopic donor nephrectomy (LDN) was first performed in 1995.[5] Today, it has grown to represent approximately 80% of donor nephrectomies and has become the standard of practice in most institutions.[6] This technique is favoured over traditional open donor nephrectomies (ODN), as it offers many benefits, including less intraoperative blood loss, reduced hospital length of stay (LOS), less postoperative pain, shorter period of convalescence, decreased morbidity, better cosmesis, similar allograft outcomes, and increased living kidney donation rates.[7-10] In keeping with the well-documented benefits of minimally invasive surgery, the majority of institutions in North America have made the transition from ODN to LDN. However, many institutions continue to offer the ODN technique in the form of a mini-flank incision thought to have many advantages over the standard flank incision for ODN. The mini-open donor nephrectomy (mini-ODN) technique offers a decreased LOS, less postoperative pain, and shorter return to work when compared to the standard open technique.[11] Recent literature shows that five out of 14 transplant programs here in Canada still offer this mini-ODN.[12]

In May of 2011, our transplant program at the University of Manitoba transitioned from the mini-ODN technique to the laparoscopic approach for living donor nephrectomy. This allowed for the unique opportunity to do a back-to-back comparison of the mini-ODN with LDN. To accomplish this,

all consecutive cases from the final three years of ODN and first three years of LDN were retrospectively reviewed to compare differences in surgical and donor outcomes and graft function. This secondarily allowed us to ensure that the newly introduced minimally invasive technique offered the same if not added benefits to patients undergoing this procedure.

Methods

Following approval of the University of Manitoba ethics review board, we performed a review of all consecutive living donor nephrectomies performed between 2007 and 2014 at our institution. A clean transition between these two techniques occurred in May 2011, with the recruitment of a new transplant surgeon trained in minimally invasive kidney surgery. A total of 183 cases were identified with 89 and 94 in the mini-ODN and LDN groups, respectively. All data was from a single-centre transplant program and involved two surgeons. A comparison between these two techniques was made with regards to surgical and postoperative outcomes. Furthermore, outcomes from the resultant recipient surgery, as well as allograft function were compared.

Demographic, past medical history, perioperative, and followup data for donors and recipients were assessed. Preoperative creatinine clearance (CrCl) values were obtained from 24-hour urine collection, and glomerular filtration rate (GFR) obtained from nuclear renogram. Operative time was defined as the time between initial incision and closing of the wound. Average cost of a case reflected cost of the operating room, surgical equipment, and the subsequent in-hospital stay. The extracted data was tabulated, and Prism GraphPad software (v6) was used for comparative statistical analyses. We used unpaired t-tests for continuous variables, and Fisher's exact tests for categorical variables. Differences between groups were considered statistically significant with a p value <0.05.

Results

We compare single-surgeon data for 89 mini-ODN cases from January 2007–March 2011, to single-surgeon data for 94 LDN cases from May 2011–December 2014. Patient demographic data for both cohorts is presented in Table 1 with no difference in gender or left vs. right-sided nephrectomy. Patients undergoing mini-ODN were found to be younger (42.3 vs. 46.0 years; p=0.0431), have a higher body mass index (BMI) (28.4 vs. 26.3; p=0.0005), and a slightly lower CrCl (113.3 vs. 121.5 mL/min; p=0.0325).

Operative, perioperative, and allograft outcomes are summarized in Table 2. LDN was associated with a reduced estimated blood loss (90.3 vs. 347.83 cc; p<0.0001), decreased number of intraoperative complications (4 vs. 11; p=0.0253), and shorter LOS (3.29 vs. 2.36 days; p<0.0001). Donor serum creatinine at discharge was also found to be lower in the LDN group (96.73 vs. 110.3 umol/L; p<0.0001), although unlikely to be of clinical significance. Operative time was found to be significantly longer in the LDN group (108.4 vs. 165.89 minutes; p<0.0001), however, no difference was found with regard to warm ischemic time (WIT) between groups. Although ODN was associated with a higher estimated blood loss, this did not translate to a statistically significant greater need for a blood transfusion (3 vs. 1; p=0.3576).

Perioperative complications were graded according to the Clavien-Dindo classification and were either Grade 1 or 2, as demonstrated in Table 2. We found no significant difference in postoperative complication rates between ODN and LDN. With regard to recipients, there was no significant difference in serum creatinine levels at one year post-transplant whether the kidney was from open or laparoscopic retrieval. Also, there was no significant difference in delayed graft function, defined as having dialysis within the first week post-transplant.

Discussion

As minimally invasive techniques continue to evolve, it is prudent to demonstrate their efficacy and safety relative to the conventional open techniques they often replace. This is of utmost importance for donor outcomes, as living kidney donors are healthy individuals undergoing surgery to improve the life of others. Although the gold standard for living kidney donation is LDN, several centres across North America still offer the mini-ODN, as it has been shown to have several advantages over the standard flank incision.

Table 1. Baselines characteristics of patients undergoing ODN and LDN

Demographic	ODN (n=89)	LDN (n=94)	p value
Gender, n (%)	M 35 (39.3), F 54 (60.7)	M 32 (34.0), F 62 (66.0)	0.5395
Age (years)	42.3 ± 11.8	46.0 ± 12.8	**0.0431**
BMI (kg/m^2)	28.4 ± 4.41	26.3 ± 3.6	**0.0005**
CrCl (mL/min)	113.3 ± 21.9	121.5 ± 24.9	**0.0325**
Laterality, n (%)	L 74 (83.1), R 15 (16.9)	L 72 (76.6), R 22 (23.4)	0.3574

F: female; L: left; LDN: laparoscopic donor nephrectomy; M: male; ODN: open donor nephrectomy; R: right.

Table 2. Operative, perioperative, and graft outcomes for patients undergoing ODN and LDN

Outcome (n)		ODN (n=89)	LDN (n=94)	p value
Estimated blood loss (cc)		347.83 ± 470.8	90.3 ± 221.1	**<0.0001**
Need for transfusion, n (%)		3 (3.4)	1 (1.1)	0.3576
Intra-operative complications (n)		1 segmental artery transected 1 ureter cautery injury 2 vena cava injuries 2 renal artery injuries 4 renal vein injuries 1 lumbar vein injury	1 pneumothorax 2 splenic lacerations 1 conversion to open	**0.0253**
Operative time (min)		108.4 ± 25.0	165.9 ± 27.0	**<0.0001**
Warm ischemic time (min)		2.0	2.0	0.1358
Length of stay (days)		3.3 ± 0.9	2.4 ± 0.8	**<0.0001**
Discharge creatinine (umol/L)		110.3 ± 23.3	97.7 ± 13.5	**<0.0001**
Postoperative complications	Clavien Dindo Grade 1 (n)	3 nausea 3 pain 1 hypertension 2 urinary tract infection	4 testicular pain 2 ileus 3 hernia 1 pain	1.0000
	Clavien Dindo Grade 2 (n)	1 deep venous thrombosis/pulmonary embolism (treated with Coumadin)	2 wound infection (treated with antibiotics) 1 urinary retention (treated with catheter)	0.3538
Delayed graft dysfunction rate		5.7%	17%	0.1218
Recipient creatinine one-year (umol/L)		115.5 ± 41.8	121.9 ± 36.1	0.3982
Cost (CAN $)		4448.00	5132.00	

LDN: laparoscopic donor nephrectomy; ODN: open donor nephrectomy.

Our results demonstrate several advantages of LDN over mini-ODN without compromising WIT and delayed graft function. These include reduced estimated blood loss, less intraoperative complications, and reduced hospital LOS.

Decreased estimated blood loss during LDN as compared to open techniques has been well-documented.[13] This is due to the minimally invasive nature of the surgery, which allows for a better visualization and dissection of the hilar vessels leading to reduced vascular complications commonly associated with open techniques. The mini-flank incision provides a small working space and limited view of the hilar vessels, which likely contributed to the increased number of vascular injuries. Of the 11 complications that occurred in the mini-ODN cohort within our analysis, 10 were vascular in nature, as opposed to none in the LDN group (Table 2). When translating this to the necessity for blood transfusions, although there were more transfusions required in the ODN group (3 vs. 1), this was not found to be statistically significant.

Along with reduced blood loss, LDN was found to have a lower rate of intraoperative complications than mini-ODN (4.3% vs. 12.4%; p=0.0253). The complications associated with LDN were in keeping with the laparoscopic nature of the procedure. This included one pneumothorax, two splenic lacerations, and one conversion to ODN. The intraoperative complication rate of LDN has been reported to range from 0– 35%.[14] While in recent literature the intraoperative complication rate has been found to be greater in patients undergoing more conventional open approaches,[15] a number of earlier reports have suggested the opposite to be true. Other studies have also reported no appreciable differences in complications between either approach.[16-20] This variability is likely multifactorial, with an improvement in intraoperative complications by LDN over time due to enhanced laparoscopic technique, improvement in equipment, and familiarity gained with a greater use of laparoscopic surgery in other urological procedures.

In our series, the LDN group had one conversion to ODN to aid in securing the renal hilum in a donor with difficult vascular anatomy. Rate of conversion from LDN to ODN ranges from 0–13.3% and is usually due to bleeding or vascular control.[21] In regards to postoperative complications, we found no major complications in either group (Clavien-Dindo 3–4). Rates of minor postoperative complications were similar in both groups, with no statistically significant difference in Clavien-Dindo Grades 1 and 2. Testicular pain was a notable complication in the LDN group (n=4); this has been reported as a common and often under-reported complication of LDN.[22]

Laparoscopic donors also benefit from a reduced hospital LOS that has been well-documented in the literature.[14-16,18-20,23-25] Despite the shorter hospital stay, the higher cost of surgical equipment needed for laparoscopy leads to a higher overall cost when compared to mini-ODN ($5132 vs.

$4448). However, although there is a higher upfront cost to a laparoscopic approach, this does not take into account the improved savings in terms of quicker recovery and shorter return to work, which has been shown in multiple other studies;[17] unfortunately, we were unable to collect this data for our study. A large meta-analysis by Nanidis et al showed that LDN vs. ODN demonstrated shorter hospital stay by 1.58 days and a quicker return to work by 2.38 weeks.[17]

A disadvantage of LDN is longer operating time compared to more conventional open techniques. This has been well-documented in numerous other studies.[13,15-20] Ultimately, the goal of the procedure is to acquire the organ with the least amount of WIT to ensure proper functioning of the allograft in the recipient. We found no difference in WIT between our mini-ODN and LDN groups. There was also no change in incidence of delayed graft function, as defined by dialysis in the first postoperative week. Renal function at one year post-transplant was also similar for both groups. The literature is varied with regards to WIT when comparing laparoscopic to open approach. A number of meta-analyses have shown higher WITs for LDN cases;[13,17] however, it was noted by Nanidis et al that when only randomized, controlled trials were considered, there was no significant difference in WIT.[17]

Limitations

Our results must be taken within the context of its limitations. This was a retrospective analysis with limitations inherent to its study design. Furthermore, baseline characteristics of patients differed between groups, likely due to the mini-ODN and LDN being performed by different surgeons with their own patient selection. Groups were found to differ in age, BMI, and CrCl at baseline. The mini-ODN group was found to have a greater BMI, which may have an impact on intraoperative complications. Also, we did not look into potential immunological differences between the two donor groups, which may have had an impact on creatinine at discharge. However, our recent change in technique from mini-ODN to LDN has allowed for a unique opportunity of a modern era, back-to-back comparison of these two techniques.

Conclusion

We demonstrate LDN provides reduced estimated blood loss, fewer intraoperative complications, and a shorter hospital LOS without compromising short-term and long-term graft outcomes as compared to the mini-ODN technique. This provides support to the growing body of literature that demonstrates LDN yields outcomes that are at least equivalent, if not superior to mini-ODN, for both donors and recipients.

Competing interests: The authors report no competing personal or financial interests.

This paper has been peer-reviewed.

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