Original Article

Recipient outcomes in total laparoscopic live donor nephrectomy with multiple renal vessels

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Abstract

Introduction: In kidney transplantation, total laparoscopic live donor nephrectomy (TLLDN) in the presence of multiple renal arteries (MRA) is technically challenging and has traditionally been associated with higher complication rates. We report our experience of using MRA grafts procured by TLLDN.

Materials and Methods: Patients undergoing TLLDN at our center (2004–2014) was identified from a prospectively maintained database and divided into single renal arteries (SRA) or MRA groups. Recipient perioperative parameters, postoperative complications, and long-term graft survival were analyzed.

Results: Of 465 patients, 106 had MRA and 359 had an SRA. There were six vascular complications in the SRA group and two in the MRA group (1.7% vs. 1.8%). There were eight ureteric complications requiring intervention in the SRA group compared to three in the MRA group (4% vs. 3%; $P = 0.45$). Acute rejection was observed in 12% of the SRA group compared to 9% in the MRA group ($P = 0.23$). One-, 5- and 10-year graft survivals were 98.2%, 91.3%, and 89.8% in the MRA group versus 98.0%, 90.4%, and 77.5% in the SRA group (log-rank $P = 0.13$).

Conclusion: The use of MRA grafts procured by TLLDN has comparable complication rates to SRA grafts and should not preclude selection for renal transplantation.

Keywords: Graft survival, kidney transplantation, laparoscopic nephrectomy, living donors, renal artery

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INTRODUCTION

In the majority of patients with end-stage renal failure, renal transplantation remains the preferred treatment option due to improved quality of life and overall survival.[1] As a result, the pressure to fulfill the need for donor grafts is growing. In order to meet this demand, donor criteria have now evolved to include grafts with multiple renal arteries (MRA), made possible in part by advances in laparoscopic and surgical techniques. Conventionally, MRA grafts were not considered to be suitable due to reservations regarding higher complication rates. Some studies have reported increased incidences of warm ischemic time (WIT), delayed graft function (DGF), vascular and urological complications with MRA grafts.[2-9] Despite this, the current literature is still inconclusive and when comparing recipient outcomes from grafts with single renal arteries (SRA) and those with MRA, there does not appear to be a significant difference in long-term graft

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survival.[10-23] With up to 35% of donors having MRA, the ability to use these grafts for transplantation improves the donor pool greatly and helps to address transplant waiting times.[24] It is not unsurprising therefore that MRA grafts are being used more frequently, although perhaps not more favorably, with encouraging results.

We present a tertiary center experience of recipient outcomes using both SRA and MRA grafts procured by total laparoscopic live donor nephrectomy (TLLDN).

MATERIALS AND METHODS

From July 2004 to December 2014, 465 patients with complete records undergoing TLLDN renal transplantation at our center were identified from a prospectively maintained departmental database. All donors were either living related or living unrelated.

Graft harvest and vascular reconstruction/ transplantation

The preoperative vascular anatomy of the donor grafts was delineated using computed tomography (CT) angiography, and split renal function was evaluated by diuretic renography. Grafts were harvested by a total laparoscopic approach (transperitoneal, 3- or 4-port) with extraction through a Pfannenstiel incision. There were no conversions to an open procedure. Left-sided grafts were preferentially procured due to a longer renal vein and the presence of MRA in a left-sided graft did not preclude its selection for transplantation. For patients with MRA, vascular reconstruction was undertaken on the back-table during the cold ischemic phase using either end-to-side, side-to-side, or a combination of the two anastomotic techniques. The standard open extraperitoneal approach was adopted for all recipient procedures. The iliac vessels, aorta or inferior vena cava were used for vascular anastomosis, depending on recipient size. For the ureteric anastomosis, an extravesical ureteroneocystostomy was performed over a ureteric stent.

Postoperative course and follow-up

Following graft implantation, patients underwent daily monitoring of serum creatinine, electrolytes, and hemoglobin. A Doppler ultrasound was performed within 24 h to evaluate graft vascular flow. Graft biopsies were taken in cases of clinically unexplained graft impairment.

The postoperative complications analyzed were vascular, urological, and acute rejection. All episodes of acute rejection were biopsy proven. Postoperative complications were recorded and stratified according to the Clavien-Dindo classification.

At discharge, patients were generally followed weekly for 3 months, monthly for 6 months, and every 3 months with urine analysis, serum creatinine level, full blood count, and immunosuppression drug level.

Statistical analysis

As described previously, patients were classified into either the SRA or MRA group. Parameters used to compare the two groups included patient demographics, site of vascular anastomosis, and ischemic times (primary and secondary WIT, cold ischemic time [CIT]). Primary WIT was defined as the time from cross-clamping of the graft during TLLDN to commencement of cold perfusion, CIT as the graft time spent in cold perfusate and secondary WIT as the time from removal of the graft from cold perfusate until reperfusion.

In addition, the incidence of postoperative complications was compared between the groups. The Pearson, Chi-square, and Student's *t*-tests were used to determine the statistical significance of any differences. Graft survival rates were compared among the two groups using Kaplan–Meier analysis and the log-rank test. $P < 0.05$ was considered statistically significant.

RESULTS

During the study, 465 patients were included. In our series, 23% of patients had MRA-91 patients with double arteries, 12 patients with triple arteries, and 3 patients with four renal arteries. Both groups were reasonably matched with regard to demographic data [Table 1].

Intraoperative differences

Patients with MRA had a statistically higher CIT (122 min vs. 62 min, $P < 0.05$) which was required for

Table 1: Patient demographics

	Single vessels	Multiple vessels	*P*
Demographics			
n	359	106	
Mean age (years)	52 (14-70)	55 (24-72)	
Male: female ratio	1.5:1	1.8:1	
Percentage with previous transplant	3.8	2.8	
Percentage predialysis	31.2	33	
Median ASA	3	3	
Median Charlson comorbidity index	3	3	
Operative details			
Primary warm ischemic time (min)	4 (3-10)	4 (2-7)	
Cold ischemic time (min)	62 (45-136)	122 (77-200)	0.01
Secondary warm ischemic time (min)	30 (28-43)	35 (25-42)	
Estimated blood loss	292	362	0.03
Complications (%)			
Vascular	1.7	1.8	
Urological	4	3	
Rejection	12	9	

back-table reconstruction. Techniques used to reconstruct the arteries were side-to-side anastomosis (56%), end-to-side anastomosis (26%), sacrificing a small polar artery (3%), or a combination of these techniques (15%). The mean estimated blood loss was also higher in the MRA group compared to the SRA group (362 vs. 292 ml, $P < 0.05$).

Postoperative complications

There were six vascular complications (1.7%) in the SRA group; two graft artery stenoses, one arterial intimal dissection, and three laparotomies for postoperative anastomotic bleeding, one of which resulted in graft loss. There were two vascular complications (1.8%) in the MRA group which were both laparotomies for postoperative anastomotic bleeding. There were eight ureteric complications (4%) requiring subsequent intervention (reimplantation or long-term ureteric stenting) in the SRA group compared to three (3%) in the MRA group. Acute rejection following renal transplant was seen in 14% of the SRA group compared to 11% in the MRA group. Overall, Clavien III/IV complications were noted in 6% of the SRA group and 7% of the MRA group [Table 1].

Graft function

About 94% of patients in the MRA group had functioning grafts at a median time follow-up of 50 months. During the study, there were 8 graft failures in the MRA group and 35 in the SRA group. One year, 5-year and 10-year graft survival were 98.2%, 91.3%, and 89.8% in the MRA group versus 98.0%, 90.4%, and 77.5% in the SRA group. Kaplan–Meier analysis showed no statistically significant difference between the two groups (log-rank $P = 0.13$).

DISCUSSION

In our institution, left-sided donor grafts are preferred as the longer renal vein makes vascular anastomosis technically easier and has also been shown to decrease operating time.[25] The practice of selecting left-sided grafts is not uncommon and has been adopted by other institutions.[20] Furthermore, previous studies have commented on an increased risk of early graft failure with right-sided donor nephrectomies.[26] In contrast, some centers have performed a large number of right-sided donor nephrectomies, albeit using hand-assisted techniques, and reported no significant difference in graft function.[27] Considering that MRA is not an uncommon variant, the very nature of preferentially selecting left-sided donor grafts regardless of arterial anatomy means that a higher number of MRA will be encountered.[24] This is reflected in our study, where 23% of donors had MRA grafts. As a result, in our practice, we perform a significant number of recipient transplants incorporating MRA grafts.

Overall, the current literature [Table 2] would support that transplanting MRA grafts is a safe procedure with no difference in long-term outcomes.[10-22] This has been supported by a large meta-analysis which showed comparable long-term outcomes for graft and patient survival.[23] Some studies, however, have suggested higher recipient postoperative complication rates with MRA grafts.[2-9] When looking at laparoscopic living donor nephrectomy (LLDN), several studies have reported increased WIT, perhaps not unsurprising given the additional time taken for multiple arterial anastomoses.[3,5,6,14,28] Despite this, the additional WIT associated with MRA grafts results in comparable 1-year graft survival rates when compared to SRA grafts.[5,6,14] In our study, there was no significant difference in WIT for MRA grafts when compared to SRA grafts. The fact that the majority of MRA in our institution are reconstructed (side-to-side, end-to-side, and combination of both) to form a common artery for single anastomosis rather than performing separate anastomoses for each individual artery, may offer an explanation. This would also account for the significantly increased CIT required for back-table vascular reconstruction, although this did not appear to affect overall long-term graft survival. The only other significant difference that was noted in our cohort

Table 2: Literature comparison summary for multiple renal artery grafts

Author/year	Cohort (*n*)	Procedure	Left:right grafts (% left side)	SRA:MRA (% MRA)	↑WIT	↑DGF	↑Vasc	↑Uro	1 year graft survival (%) (single:multiple)
Troppmann 2001	78	LDN	79:0 (100)	57:21 (27)	…	No	No	No	97:95
Hsu 2003	353	LDN	333:20 (94)	277:76 (22)	MRA	…	No	No	95:93
Carter 2005	361	LDN	312:49 (86)	312:49 (14)	MRA	No	No	MRA	…
Desai 2007	303	LDN	…	245:58 (19)	MRA	…	…	…	94:93
Paragi 2011	976	LDN/HAL	846:27 (97)	799:177 (18)	…	MRA	No	No	99:94
Tyson 2011	510	LDN	…	393:117 (23)	…	MRA	No	No	…
Meyer 2012	130	LDN/HAL	97:33 (75)	108:22 (17)	MRA	No	No	No	…
Chedid 2013	1134	HAL	865:269 (76)	924:210 (19)	…	…	No	No	95:96
Cooper 2013	997	LDN/HAL	968:29 (97)	742:255 (26)	MRA	MRA	No	MRA	93:87
Bandin Musa 2016	165	HAL	160:5 (97)	134:31 (19)	MRA	No	…	…	…

LDN: Laparoscopic donor nephrectomy, HAL: Hand-assisted laparoscopic, SRA: Single renal artery, MRA: Multiple renal arteries, WIT: Warm ischaemic time, DGF: Delayed graft function, Vasc: Vascular complications, Uro: Urological complications, ↑: Increased

was increased estimated blood loss with MRA, although this has been commented on in other papers.[4] DGF, although not included in our study, is another variable that has been analyzed with MRA grafts procured by LLDN; some studies have demonstrated a higher incidence with MRA grafts although with no difference in graft survival at 1 year when compared to SRA grafts.[5,17,21] There has been some concern regarding vascular complications with MRA grafts, most commonly arterial stenosis and thrombosis. This has however been demonstrated in studies whose cohorts have included deceased donors and open donor nephrectomies.[2,9] When looking at vascular complications in studies that have included only LLDN, an increased incidence is not reported.[3,5,13,14,17,20,21,29] This is comparable to our study; out of six vascular complications, the majority of which were hemorrhagic, only two arterial stenoses were observed, both of which were in the SRA group. We did not report any arterial stenosis or thrombosis in the MRA group and there was no significant difference in vascular complications between MRA and SRA grafts. Concern around the transplantation of MRA grafts has also focused on an increased reported incidence of urological complications in the recipient. Both Carter *et al*. and Cooper *et al*. demonstrated a statistically significant increase in urological complications in MRA graft recipients from LLDN than with SRA graft recipients.[3,5] In our study, however, we did not find this to be the case with no statistical difference in urological complications between MRA and SRA grafts.

Despite the potential postoperative complications associated with transplanting MRA grafts, the overall long-term outcomes seem to be encouraging. Comparable 1-year graft survival rates in recipients have been reported when comparing MRA and SRA grafts procured by LLDN.[3,5,6,13,14,17,20,21,29] We also report good 1-year and long-term graft survival rates in MRA grafts with no statistically significant difference to SRA grafts.

CONCLUSION

The use of MRA grafts procured from TLLDN in renal transplantation is a safe procedure with comparable complication rates to SRA grafts. There is no statistical difference in long-term graft survival between MRA and SRA grafts. The presence of MRA in a donor graft should not preclude its selection for renal transplantation

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Conflicts of interest
There are no conflicts of interest.

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