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Early outcomes of laparoscopic donor nephrectomy with multiple renal arteries

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ABSTRACT

Purpose: We evaluated our experience with laparoscopic donor nephrectomy in patients with multiple renal arteries, comparing operative outcomes and early graft function with patients with a single renal artery.

Materials and Methods: From January 2003 to February 2009, 130 patients underwent laparoscopic donor nephrectomy at our institution, 108 (83%) with a single renal artery and 22 (17%) with multiple arteries. Donor and recipient outcomes for single artery and multiple arteries allografts were compared.

Results: The LDN operative time was similar between the single artery and multiple arteries groups (162 vs 163 min, respectively, p = 0.87). Allografts with multiple arteries had significantly longer warm ischemia time (3.9 vs 4.9 min, p = 0.05) and cold ischemia time (72 vs 94 min, p < 0.001) than those with single artery. The conversion rate was similar between single and multiple arteries groups (6% vs 4.5%, respectively, p = 0.7). Multiple arteries grafts had a non statistically significant higher rate of poor graft function when compared to single artery grafts (23% vs 12%, respectively, p = 0.18). Five patients in the single artery group (4.6%) and one patient in the multiple arteries group (4.5%) needed dialysis during the first postoperative week. Overall, recipient complication rates were similar between single and multiple arteries groups (12.9% vs 18.1%, respectively, p = 0.51).

Conclusion: Laparoscopic donor nephrectomy with multiple arteries was associated with a non statistically significant higher rate of poor early graft function. The procedure appears to be safe in patients with multiple arteries, with similar complications rates. Multiple arteries should not be a contraindication for laparoscopic donor nephrectomy.

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INTRODUCTION

Renal transplantation is the treatment of choice for patients with end-stage renal disease. Unfortunately, donor organ shortage has become a problem preventing the wider application of this treatment (1). Since the first laparoscopic donor nephrectomy (LDN) performed by Ratner et al. in 1995, the procedure has gained worldwide acceptance and popularity (2). The use of LDN may remove some of the disincentives of living donor transplantation, increasing the pool of kidneys available for transplantation with an increase of voluntary kidney donors (3). Some of the advantages of the LDN include less donor morbidity, lower hospital stay, and better convalescence, with similar short and long term outcomes when compared to open surgery (4-8).

The presence of multiple renal arteries is considered the most common renal anatomic

variation. Autopsy studies showed that the prevalence of multiple renal arteries may vary from 18 to 30%, and 15% of them being bilateral (9). Initially, multiple arteries were considered inappropriate for laparoscopic removal during kidney donation. With increasing experience, LDN has now been extended to donors with multiple renal arteries and extending this indication would be important to increase the pool of available kidneys for transplantation (1). However, the procedure in patients with multiple renal arteries is still technically challenging, and concerns regarding prolonged operative times, ischemia time, and increased risk of complications persists. In the present study, we evaluated our experience with LDN in patients with multiple renal arteries, comparing operative outcomes and early graft function with patients with a single renal artery.

MATERIALS AND METHODS

Between January 2003 to February 2009, 130 consecutive patients who underwent LDN at our institution were retrospectively reviewed. All donor patients underwent a preoperative evaluation that consisted of history and physical examination, serum chemistry studies and imaging. The arterial anatomy was delineated by selective renal angiography or computed tomography angiogram. All patients underwent transperitoneal LDN through a three or four-port approach. The renal artery and vein were secured with two Hem-o-Lok™ (Weck Closure Systems™) clips on the aortic side and vena cava side, respectively. From 2003 to 2005 all LDN were performed using a hand-assisted device. After this period all procedures were performed by a pure laparoscopic approach, as previously described (10). Left kidney was preferably procured due to its longer renal vein extent, unless an anatomical variation was observed during preoperative imaging.

Warm ischemia time was defined as the time from clamping until allograft perfusion with cold perfusate. The recipient procedure was performed using the standard extraperitoneal approach. Single renal vein was first anastomosed to the external iliac vein. An end-to-side anastomosis of the allograft renal artery with the recipient external iliac artery was usually preferred. In grafts with multiple renal arteries, bench end-to-side accessory artery-to-main artery anastomosis or side-to-side conjoint artery-to-artery anastomosis using 7-0 Prolene™ continuous sutures were performed.

We compared donor and recipient results for single artery (SA) and multiple arteries (MA) allografts. Donor parameters analyzed included age, gender, operative time, warm ischemia time, and estimated blood loss. Recipient parameters included age, gender, cold ischemia time, creatinine level at day 5, slow and delayed graft function rates, and early complications. Delayed graft function was defined as the need for hemodialysis on post-operative day 1-7. Slow graft function was defined as POD 5 serum creatinine $\geq$ 3 mg/dL without need for hemodialysis on POD 1-7. An allograft was considered to have a poor early graft function (EGF) if it experienced delayed graft function or slow graft function (11). Complications were classified as vascular (bleeding, hematoma, thrombosis, stenosis), ureteral (stricture, leak), and others (lymphocele, wound dehiscence, infection). Complications were graded using the Clavien-Dindo classification (12). Comparisons between categorical variables were performed using Chi-square tests and between continuous variables were performed using Mann-Whitney test. The Shapiro-Wilk test was performed to test for the normality of the sample. Due to small number of events a multivariate analysis for predictors of poor graft function was not attempted. Statistical calculations were performed with Stata 8.

RESULTS

Patient characteristics

In total, 108 allografts had SA (83%) and 22 had MA (17%). Donor and recipient demographic characteristics are shown in Table-1. There was no statistically significant difference between SA and MA patients with regards to median donor age (39 vs 36 years, respectively, p = 0.27), donor gender (40% vs 27% male donors, p = 0.27), recipient gender (58% vs 59% male recipients, p = 0.95), LDN side (76% vs 68% left kidneys procured, p = 0.45), and LDN technique

Table 1 - Patient demographics divided by number of arteries.

	Single artery (n = 108)	Multiple arteries (n = 22)	Total (n = 130)	P value
Donor age, median (IQR)	39 (32 - 46)	36 (31 - 43)	39 (32 - 46)	0.27
Donor gender				0.27
Male	43 (40)	6 (27)	49 (38)	
Female	65 (60)	16 (73)	81 (62)	
Recipient age, median (IQR)	37 (28 - 47)	47 (37 - 53)	40 (30 - 50)	0.02
Recipient gender				0.95
Male	63 (58)	13 (59)	76 (58)	
Female	45 (42)	9 (41)	54 (42)	
LDN side				0.45
Right	26 (24)	7 (32)	33 (25)	
Left	82 (76)	15 (68)	97 (75)	
Hand-assisted	50 (46)	7 (32)	57 (44)	0.21

IQR = inter quartile range; **LDN =** laparoscopic donor nephrectomy.

(46% vs 32% hand-assisted LDN, p = 0.21). Recipients of allografts with MA were significantly older when compared with patients who received SA allografts (median age 47 vs 37 years, respectively, p = 0.02).

Surgical events

Table-2 summarizes operative events for both groups. Briefly, the median LDN operative time was similar between the SA and MA groups (162 vs 163 min, respectively, p = 0.74). Allografts with MA had significantly longer warm ischemic time (3.9 vs 4.9 min, p = 0.01) and cold ischemic time (72 vs 94 min, p < 0.001) than those with SA. The conversion rate was similar between SA and MA groups (6% vs 4.5%, respectively, p = 0.7). Overall, eight patients had an intraoperative bleeding requiring open conversion to gain hemostasis. Seven of these patients had a single artery, and the reason for bleeding was a venous lesion during dissection in five patients and a clip slippery in two patients. One patient had a conversion in the MA group due to a venous lesion during hilar dissection.

Recipient early outcomes

The early graft function is summarized in Table-2. Multiple arteries grafts had a non statistically significant higher rate of poor graft function when compared to SA grafts (23% vs 12%, respectively, p = 0.18). Five patients in the SA group (4.6%) and one patient in the MA group (4.5%) needed dialysis during the first postoperative week. The mean serum creatinine in the 5th postoperative day for the SA group was 1.86 mg/dL and for the MA group was 2.49 mg/dL. This difference was not statistically significant (p = 0.08). Overall, early recipient complication rates were similar between SA and MA groups (12.9% vs 18.1%, respectively, p = 0.51). The complications grade was also similar between both groups. Eleven patients (10.2%) in the SA group and three

(13.6%) in the MA experienced major complications (grade III-V). One patient in the SA group with a renal vein thrombosis lost the allograft, and one patient on each group had sepsis and died after renal transplantation. Analyzing separately, the rate of vascular complications was similar between SA and MA groups (2.8% vs 4.5%, respectively, p = 0.66) as well as the rate of ureteral complications (5.6% vs 4.5%, respectively, p = 0.85). Table-3 details the complications for both groups.

DISCUSSION

In this study, we compared LDN performed in kidneys with MA and kidneys with a SA and found that recipient complications rates,

Table 2 - Operative and early function data for both groups.

	Single artery	Multiple arteries	Total	P value
Operative time, min (SD)	162 (46.3)	163 (37.5)	162 (44.9)	0.74
WIT, min (SD)	3.9 (2)	4.9 (2.4)	4.1 (2.1)	0.01
CIT, min (SD)	72 (16.8)	94 (23.1)	77 (20.5)	< 0.001
EBL, mL (SD)	267 (377)	245 (165)	264 (351)	0.17
Poor graft function (%)†	13 (12)	5 (23)	18 (14)	0.18
Delayed graft function (%)†	5 (4.6)	1 (4.5)	6 (4.6)	0.98
Mean SCr, mg/dL (SD)	1.86 (1.42)	2.49 (1.72)	1.96 (1.49)	0.08

SD = standard deviation; **WIT =** warm ischemia time; **CIT =** cold ischemia time; **EBL =** estimated blood loss; **SCr =** serum creatinine.
†Delayed graft function: patients who needed dialysis during the first post-operative week. Poor graft function: patients who had creatinine > 3 mg/dL or needed dialysis during the first PO week.

Table 3 - Complication rates by group.

	Single Artery	Multiple Arteries	P Value
All complications	14 (12.9%)	4 (18.1%)	0.51
Vascular	3 (2.8%)	1 (4.5%)	0.66
Thrombosis	1	0	
Stenosis	2	1	
Ureteral	6 (5.6%)	1 (4.5%)	0.85
Others	5 (4.6%)	2 (9.1%)	0.39
Lymphocele	1	1	
Wound dehiscence	1	0	
Infection	3	1	

especially ureteral and vascular complications, were similar between both groups. We also found that patients who received allografts with MA had longer warm and cold ischemia times. These longer ischemia times translated into nearly a double of the rate of poor EGF for MA patients when compared to SA patients (23% vs 12%, respectively). However, this difference was not statistically significantly and was not associated with a higher recipient need for dialysis during the first postoperative week.

In patients with MA, there is an increased risk of injury from more extensive dissection (13). The requirement for complicated vascular reconstruction and more difficult anastomosis at the time of implantation impose additional ischemic injury and subsequent reperfusion injury (13). This extended dissection and the need for back-table reconstruction have been shown, by some authors, to be associated with an increased risk for urological and vascular complications (9,14,15). Roza et al. analyzed 42 living donor open nephrectomies with multiple arteries and observed 8 patients (19%) with urological complications and 3 (7%) with vascular complications (9). Carter et al. also showed a higher rate of ureteral complications in patients with multiple arteries (17% vs 3%) when analyzing 361 LDN. The authors concluded that this higher rate could be a result of insufficient perfusion in the kidney's lower pole, probably related to excessive traction or cautery lesion during dissection (14). However, other papers analyzing LDN did not show a higher incidence of vascular and ureteral complications when harvesting kidneys with multiple arteries (16-18). In our study, the rate of vascular and ureteral complications was similar on both groups. At our institution, the ureteral dissection is performed carefully to maintain an adequate vascular supply to the lower pole and distal ureter. The back-table reconstruction and vascular anastomosis are meticulously performed by an experienced vascular surgeon to ensure an adequate lumen in the anastomosis in order to prevent thrombosis or technical errors.

Results from previous studies comparing renal function outcomes in patients with MA and SA have been variable (13,16-20). Kuo et al.. showed similar functional outcomes for patients with one, two or three renal arteries. The authors analyzed 124 patients who underwent LDN, 83 patients with a single artery, 33 with two arteries and 8 with three arteries, with 1-year graft survival rates of 96.1%, 90.9% and 90%, respectively (17). Similar results were published by other authors (16,17,19). In the other hand, Paramesh et al. when analyzing 278 LDN during a 10-year period, showed in a multivariable logistic regression analysis that MA was an independent risk factor for acute rejection. The authors also showed that the graft function at 6 and 12 months was significantly lower in the MA group than SA group, and this trend persisted for 3 years after transplant (13). In the present study, the MA group had a higher rate of poor EGF when compared to the SA group (23% vs 12%, respectively). This difference was not statistically significant. However, we must acknowledge that this difference may be of clinical relevance since patients with MA had nearly a double of poor EGF. For this reason, at our institution, we usually procure the kidney with a single artery, regardless of the side, and perform a LDN in kidneys with multiple arteries only when both kidneys have this anomaly.

Warm and cold ischemia times have been shown to be associated with worst allograft outcomes (11,21,22). Sasaki et al. analyzing 100 patients who underwent LDN showed that warm ischemia time longer than 10 minutes was associated with acute tubular necrosis and creatinine levels higher than 2 mg/dL in the 7th post-operative day (22). Furthermore, the authors suggest that the WIT should be less than 5 minutes to ensure the quality of renal transplantation. In our study, warm and cold ischemia times were the only variables analyzed that we found to be statistically different between MA and SA allografts. However, both groups had an acceptable total ischemia time. The other surgical factors analyzed, such as operative time and estimated blood loss, were similar, which is in accordance with previously published data (16,23).

The study has several limitations that deserve to be mentioned. First, this is a retrospective study with a small number of patients, especially in the MA group. If we had analyzed more

patients the results could be different, especially renal function outcomes. Second, our study lacks information on long-term results and the renal function analysis was based only on early graft function. Although this is suboptimal, previous reports have shown that early function results are associated with worst long-term outcomes. For example, Nogueira et al., using the same poor EGF definition as ours, demonstrated that renal allograft survival is significantly worse in patients with poor early graft function, with more than double the risk for graft failure in these subjects compared to those with adequate initial graft function (11). The authors also found inferior renal function at 1 year and worse rejection-free survival in this group. Third, we did not differentiate large renal arteries, such as polar arteries, from small branches that are more susceptible to vascular complications but do not pose a significant compromise in the kidney's vascular supply. These small branches sometimes cannot be adequately assessed during Doppler ultrasound and for this reason the vascular complications rate could even be higher. Despite these limitations, based on our results and others, we believe that multiple arteries should not be a contraindication for renal transplantation. However, the patient must be aware that LDN in kidneys with MA may be associated with worst early renal function results.

CONCLUSIONS

Laparoscopic donor nephrectomy appears to be safe in patients with multiple renal arteries, with similar complications rates when compared to single artery allografts. The cold and warm ischemia times were significantly longer in the multiple arteries group. Allografts with multiple arteries had a non statistically significant higher rate of poor early graft function when compared to single artery allografts. Nevertheless, we believe that multiple arteries should not be a contraindication for laparoscopic donor nephrectomy.

CONFLICT OF INTEREST

None declared.

REFERENCES

1. Saidi R, Kawai T, Kennealey P, Tsouflas G, Elias N, Hertl M, et al.: Living donor kidney transplantation with multiple arteries: recent increase in modern era of laparoscopic donor nephrectomy. Arch Surg. 2009; 144: 472-5.
2. Ratner LE, Ciseck LJ, Moore RG, Cigarroa FG, Kaufman HS, Kavoussi LR: Laparoscopic live donor nephrectomy. Transplantation. 1995; 60: 1047-9.
3. Ratner LE, Hiller J, Sroka M, Weber R, Sikorsky I, Montgomery RA, et al.: Laparoscopic live donor nephrectomy removes disincentives to live donation. Transplant Proc. 1997; 29: 3402-3.
4. Flowers JL, Jacobs S, Cho E, Morton A, Rosenberger WF, Evans D, et al.: Comparison of open and laparoscopic live donor nephrectomy. Ann Surg. 1997; 226: 483-9; discussion 489-90.
5. Percegona LS, Bignelli AT, Adamy A Jr, Machado C, Pilz F, Meyer F, et al.: Early graft function in kidney transplantation: comparison between laparoscopic donor nephrectomy and open donor nephrectomy. Transplant Proc. 2008; 40: 685-6.
6. Ratner LE, Kavoussi LR, Sroka M, Hiller J, Weber R, Schulam PG, Montgomery R: Laparoscopic assisted live donor nephrectomy--a comparison with the open approach. Transplantation. 1997; 63: 229-33.
7. Ratner LE, Montgomery RA, Kavoussi LR: Laparoscopic live donor nephrectomy: the four year Johns Hopkins University experience. Nephrol Dial Transplant. 1999; 14: 2090-3.
8. Wilson CH, Sanni A, Rix DA, Soomro NA: Laparoscopic versus open nephrectomy for live kidney donors. Cochrane Database Syst Rev. 2011; (11): CD006124.
9. Roza AM, Perloff LJ, Naji A, Grossman RA, Barker CF: Living-related donors with bilateral multiple renal arteries. A twenty-year experience. Transplantation. 1989; 47: 397-9.
10. Percegona LS, Bignelli AT, Adamy A Jr, Pilz F, Chin EW, Meyer F, et al.: Hand-assisted laparoscopic donor nephrectomy: comparison to pure laparoscopic donor nephrectomy. Transplant Proc. 2008; 40: 687-8.
11. Nogueira JM, Haririan A, Jacobs SC, Weir MR, Hurley HA, Al-Qudah HS, et al.: The detrimental effect of poor early graft function after laparoscopic live donor nephrectomy on graft outcomes. Am J Transplant. 2009; 9: 337-47.
12. Dindo D, Demartines N, Clavien PA: Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg. 2004; 240: 205-13.
13. Paramesh A, Zhang R, Florman S, Yau CL, McGee J, Al-Abbas H, et al.: Laparoscopic procurement of single versus multiple artery kidney allografts: is long-term graft survival affected? Transplantation. 2009; 88: 1203-7.

14. Carter JT, Freise CE, McTaggart RA, Mahanty HD, Kang SM, Chan SH, et al.: Laparoscopic procurement of kidneys with multiple renal arteries is associated with increased ureteral complications in the recipient. Am J Transplant. 2005; 5: 1312-8.
15. Fuller TF, Deger S, Büchler A, Roigas J, Schönberger B, Schnorr D, et al.: Ureteral complications in the renal transplant recipient after laparoscopic living donor nephrectomy. Eur Urol. 2006; 50: 535-40; discussion 540-1.
16. Desai MR, Ganpule AP, Gupta R, Thimmegowda M: Outcome of renal transplantation with multiple versus single renal arteries after laparoscopic live donor nephrectomy: a comparative study. Urology. 2007; 69: 824-7.
17. Hsu TH, Su LM, Ratner LE, Trock BJ, Kavoussi LR: Impact of renal artery multiplicity on outcomes of renal donors and recipients in laparoscopic donor nephrectomy. Urology. 2003; 61: 323-7.
18. Fettouh HA: Laparoscopic donor nephrectomy in the presence of vascular anomalies: evaluation of outcome. J Endourol. 2008; 22: 77-82.
19. Benedetti E, Troppmann C, Gillingham K, Sutherland DE, Payne WD, Dunn DL, et al.: Short- and long-term outcomes of kidney transplants with multiple renal arteries. Ann Surg. 1995; 221: 406-14.
20. Paragi PR, Klaassen Z, Fletcher HS, Tichauer M, Chamberlain RS, Wellen JR, et al.: Vascular constraints in laparoscopic renal allograft: comparative analysis of multiple and single renal arteries in 976 laparoscopic donor nephrectomies. World J Surg. 2011; 35: 2159-66.
21. Abreu SC, Goldfarb DA, Derweesh I, Thornton J, Urbain JL, Mascha E, et al.: Factors related to delayed graft function after laparoscopic live donor nephrectomy. J Urol. 2004; 171: 52-7.
22. Sasaki TM, Finelli F, Bugarin E, Fowlkes D, Trollinger J, Barhyte DY, et al.: Is laparoscopic donor nephrectomy the new criterion standard? Arch Surg. 2000; 135: 943-7.
23. Kuo PC, Cho ES, Flowers JL, Jacobs S, Bartlett ST, Johnson LB: Laparoscopic living donor nephrectomy and multiple renal arteries. Am J Surg. 1998; 176: 559-63.

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EDITORIAL COMMENT

Since the first descriptions of the laparoscopic donor nephrectomy on 1995, the renal transplantation laparoscopic surgery has continuously increased. Despite of the presence of renal donors with multiple renal arteries has initially been considered as a contraindication to the LDN, the upgrade of surgery technique and the experience of transplantation surgeons has increased over time and the challenges to perform LDN with MRA were overcome.

The authors evaluated your experience with 130 patients submitted to a laparoscopic donor nephrectomy, comparing the results on patients with unique arteries versus the ones with multiple arteries, by the analysis of operational surgery results and precocious and late function of the graft.

Donor parameters analyzed included age, gender, operative time, warm ischemia time, estimated blood loss and recipient parameters included age, gender, cold ischemia time, creatinine level at day 5, slow and delayed graft function rates, and early complications.

The LDN operative time was similar between the single artery and multiple arteries groups. Allograft with multiple arteries had significantly longer warm ischemia time and cold ischemia time than those with single artery. The conversion rate was similar between single and multiple arteries groups. Multiple arteries grafts had a non statistically significant higher rate of poor graft function when compared to single artery grafts respectively. Overall, recipient complication rates were similar between single and multiple arteries groups.

The own authors does a self evaluation into your manuscript, since it is a retrospective study with a small sample of patients, especially in the multiple arteries group and the results regarding the renal function could be different. Second, the renal function analysis was based only on early graft

function results, because previous reports have shown that early function results are associated with worst long term outcomes. Finally, they did not differentiate large renal arteries, such as polar arteries.

The authors concluded that several renal arteries represent a special challenge both on donor surgery and implant of the renal graft. However, the kidney nephrectomy laparoscopic with multiple arteries, regardless of the amount, it is feasible and does not have any significative impact on the graft result.

Since background results are not evenly recorded between the transplant communities, the referred article gives your contribution in the search of this consensus.

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