Outcome of Renal Transplantation with Multiple Versus Single Renal Arteries After Laparoscopic Live Donor Nephrectomy: A Comparative Study

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OBJECTIVES To compare donor morbidity and recipient outcomes in patients with a single artery versus multiple arteries undergoing laparoscopic donor nephrectomy.

METHODS A total of 303 consecutive laparoscopic donor nephrectomies were performed. Data from the group with multiple arteries (n = 27) (group I) were compared with those from the groups with single renal artery (n = 245) (group IIA) and early branching renal artery resulting in two artery recipient anastomoses (n = 31) (group IIB), in terms of donor and recipient outcomes.

RESULTS Laparoscopic donor nephrectomy was technically successful in all 303 patients without need for open conversion. The graft retrieval time was higher in group I and group IIB compared with group IIA (3.9 ± 1.4 and 3.9 ± 0.8 versus 3.5 ± 1.0 minutes). Similarly, warm ischemia time was significantly higher in groups I and IIB versus group IIA (7.2 ± 1.9 and 6.7 ± 1.9 versus 5.6 ± 1.8 minutes). Creatinine level at day 1 was higher in group I compared with group IIA (2.4 ± 1.4 versus 1.9 ± 0.7 mg/dL). However, there was no significant difference in creatinine levels at 1 month and 1 year among the three groups. Overall graft survival in groups I, IIA, and IIB was 92%, 94.4%, and 94%, respectively.

CONCLUSIONS Laparoscopic donor nephrectomy in the presence of multiple renal arteries is feasible and safe. Additionally, long-term graft survival and graft function at 1 month and 1 year are not adversely impacted by the presence of multiple renal arteries in grafts procured laparoscopically. UROLOGY 69: 824–827, 2007. © 2007 Elsevier Inc.

Since the initial report by Ratner *et al.* in 1995,[1] laparoscopic donor nephrectomy (LDN) has gained in worldwide popularity. In addition to minimizing donor morbidity, hospital stay, and convalescence, LDN has also been shown to provide equivalent short- and long-term renal allograft functional outcomes compared with open surgery. With increasing experience, LDN is being extended to donors with multiple renal arteries; however, this is technically challenging, and concern regarding prolonged warm ischemia time exists.

Autopsy studies have suggested 18% to 30% prevalence rates of multiple renal arteries, with 15% being bilateral.[2] This becomes important especially in developing countries, where live donor nephrectomy forms the major graft pool.

In this study we compare donor morbidity and recipient outcomes in patients undergoing LDN with single artery versus multiple arteries.

MATERIAL AND METHODS

Between October 2002 and May 2006, 303 transperitoneal laparoscopic living donor nephrectomy procedures were performed at our institute. Of these, 27 patients (8.9%) had multiple renal arteries (25 double, 1 triple, and 1 four vessels), 31 patients (10.2%) had early branching, and the remaining 245 patients (80.8%) had a single renal artery. Thirty-one patients had an early branching resulting in two artery recipient anastomoses. All 303 patients underwent standard transperitoneal LDN through a three- or four-port approach. The arterial anatomy was delineated by selective renal angiography in all cases. The renal artery was secured with two Hem-o-Lok (Weck Closure Systems, Teleflex Medicals) clips on the aortic side, leaving a 1- to 2-mm cuff of artery beyond the second clip. In cases of multiple arteries, the smaller artery was secured first and the main artery later to minimize ischemia time to the majority of the renal parenchyma. We also prefer to ligate the renal vein using the Hem-o-Lok clip.

The retrieved graft was perfused with cold perfusate until the efflux was clear. Warm ischemia time was defined as the time

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Table 1. Donor demographic and intraoperative outcome data

Characteristic	Group I (n = 27)	Group IIA (n = 245)	Group IIB (n = 31)	*P* Value, I vs. IIA	*P* Value, I vs. IIB	*P* Value, IIA vs. IIB
Age (yr)	44.0 ± 13.3	45.3 ± 10.3	45.3 ± 12.4	0.27	0.35	0.50
BMI (kg/m^2)	24.0 ± 4.9	23.9 ± 4.8	24.8 ± 7.0	0.46	0.31	0.17
Operative time (min)	166.3 ± 49.1	147.6 ± 44.1	162.4 ± 41.5	0.02*	0.37	0.04*
Retrieval time (min)	3.9 ± 1.4	3.5 ± 1.0	3.9 ± 0.8	0.03*	0.50	0.01*
Warm ischemia time (min)	7.2 ± 1.9	5.6 ± 1.8	6.7 ± 1.9	0.0001*	0.16	0.0008*
Hemoglobin drop (g/dL)	1.9 ± 1.3	1.6 ± 1.1	1.7 ± 1.0	0.09	0.25	0.31
Starting of the oral fluids (hr)	19.0 ± 2.5	19.5 ± 3.1	19.3 ± 3.0	0.20	0.34	0.37
Analgesia (mg tramadol)	100 ± 54.0	111.9 ± 72.5	120.5 ± 68.1	0.20	0.10	0.26
No. of ports	3.8 ± 0.5	3.7 ± 0.5	3.7 ± 0.5	0.16	0.22	0.50
Days of stay	4.4 ± 1.5	4.2 ± 0.9	4.5 ± 1.1	0.15	0.38	0.28
Blood transfusion	0	1	1			

BMI = body mass index.
Data presented as mean ± standard deviation or number. Group I: double renal artery; group IIA: single renal artery; group IIB: early branching.
* Statistically significant (Student's *t* test).

from clamping of the renal artery until obtaining clear efflux from renal vein on the bench. Time from clamping of the renal artery until the graft was delivered into the ice slush constituted the graft retrieval time. Single renal vein was first anastomosed to the external iliac vein. Single-artery graft was anastomosed to either the internal iliac artery or to the external iliac artery, depending on the condition of the recipient artery. In grafts with multiple renal arteries, bench anastomosis was carried out using 6-0 Prolene continuous sutures in a side-to-side double-barrel fashion. In cases of disproportionate caliber or wide distance between the two vessels, the arteries were anastomosed separately to internal and external iliac arteries. At our institute we routinely perform graft Doppler imaging in the immediate postoperative period to confirm adequate graft perfusion, and this was done more frequently for those who had bench surgery or separate anastomosis.

The donors and recipients were divided into three groups: group I: donors with double renal arteries (n = 27); group IIA: donors with a single renal artery (n = 245); and group IIB: donors with early branching (n = 31). Donor parameters evaluated were age, body mass index, operative time, graft retrieval time, warm ischemia time, hemoglobin level, starting of the oral fluids, analgesia required, number of ports, days of stay, and blood transfusion.

Recipient parameters evaluated included age, total ischemia time, and serum creatinine level at 0, 1, and 5 days and at 1, 6, and 12 months.

Statistical analysis was performed with Student's *t* test. The graft outcome was evaluated by Kaplan-Meier survival probability.

RESULTS

Donor demographic and intraoperative outcome data are presented in Table 1. All groups were similar in terms of age and body mass index. All 303 patients were technically successful without need for open surgery. The patients in groups I and IIB had significant longer warm ischemia time, longer graft retrieval time, and longer operative time as compared with group IIA. However, all three groups were equivalent in terms of postoperative analgesia requirement, number of ports, start of orals, and hospital stay. Intra- and postoperative complications included splenic injury in 2 patients (1 each in groups I and IIA), pancreatic injury in 1 (group IIB), bowel injury in 1 (group IIA), mesenteric tear in 1 (group IIA), paralytic ileus in 3 (1 in each group), ureteric leak in 4 (3 in group IIA and 1 in group I), hemorrhage in 1 (group IIA), and pneumothorax in 1 (group IIA). None of the complications were related to the number of vessels.

On evaluation of recipient data (Table 2), total ischemia time was significantly higher in groups I and IIB as compared with group IIA. Decrease in serum creatinine levels was significantly slower in recipients with double renal arteries. However, there was no significant difference in creatinine levels at 5 days, 1 month, 6 months, and 1 year in any of the three groups. There was no significant difference in the best creatinine level achieved in any of the groups. The recipient morbidity was no different among the three groups, as shown in Table 3. The indications for graft nephrectomy were as follows: in group IIB, pseudoaneurysm at the site of arterial anastomosis; in group IIA, graft arterial thrombosis in 1 patient, mycotic aneurysm in 3, and acute irreversible vascular rejection in 2. Ureteric complications were observed in 4 patients (1.5%): 1 was in the double-vessel group and the remaining 3 in the single-vessel group. All had developed postoperative ureteric leak, and 3 required re-exploration and ureteroneocystostomy. One patient required placement of a drain in the perivesical space. All complications were successfully treated. Recipient mortality was secondary to infective complications in 8 patients and intracranial hemorrhage in 2. Overall graft survival in groups I, IIA, IIB was 92%, 94.4%, and 94%, respectively.

COMMENT

Laparoscopic donor nephrectomy has been shown to be less morbid than open donor nephrectomy. As a result of reduced morbidity and improved cosmesis, the proportion of voluntary kidney donors is expected to increase.[3]

The availability of reports on outcomes of laparoscopi-

Table 2. Recipient demographic and outcome data

Characteristic	Group I (n = 27)	Group IIA (n = 245)	Group IIB (n = 31)	*P* Value, I vs. IIA	*P* Value, I vs. IIB	*P* Value, IIA vs. IIB
Age (yr)	34.1 ± 13.7	37.0 ± 11.7	33.9 ± 12.5	0.11	0.47	0.08
TIT (min)	74.7 ± 18.5	55.1 ± 11.7	63.0 ± 13.4	0.001*	0.003*	0.0001*
Serum Cr (mg/dL)	4.7 ± 1.6	4.6 ± 0.8	4.8 ± 1.4	0.29	0.40	0.12
Day 0						
Day 1	2.4 ± 1.4	1.9 ± 0.7	2.1 ± 0.8	0.001*	0.15	0.01
Day 5	1.1 ± 0.7	1.1 ± 0.7	1.0 ± 0.5	0.50	0.26	0.22
Month 1	1.1 ± 0.4	1.2 ± 0.5	1.1 ± 0.2	0.16	0.50	0.14
Month 6	1.3 ± 0.5	1.3 ± 0.5	1.2 ± 0.3	0.50	0.18	0.14
Year 1	1.3 ± 0.5	1.3 ± 0.4	1.2 ± 0.5	0.50	0.23	0.10
Best Cr (mg/dL)	1.0 ± 0.4	1.0 ± 0.2	1.0 ± 0.3	0.50	0.50	0.50

TIT = total ischemia time; Cr = creatinine.
Data presented as mean ± standard deviation. Group I: double renal artery; group IIA: single renal artery; group IIB: early branching.
* Statistically significant (Student's *t* test).

Table 3. Recipient morbidity and mortality

Parameter	Group I (n = 27)	Group IIA (n = 245)	Group IIB (n = 31)
Vascular rejection	3	5	1
Acute cellular rejection	3	8	3
Acute tubular necrosis	8	20	8
Graft nephrectomy	0	6	1
Death	1	9	0

Group I: double renal artery; group IIA: single renal artery; group IIB: early branching.

cally retrieved grafts has made LDN more acceptable.[4,5] Because of the ability to rapidly control hemorrhage and because of the overall reduction in the incidence of vascular complications, LDN is now being extended to those with multiple vessels.[6,7] Even obese donors are no longer contraindicated for LDN.[8]

Presently available imaging techniques have a sensitivity of 98% in identifying the number of vessels preoperatively.[9] Rarely the surgeon faces unexpected hilar vascular anomalies. In our experience, we had one instance of a donor whose preoperative imaging suggested two renal arteries but intraoperatively was found to have four.

Conventionally Endo GIA staplers (U.S. Surgicals, Norwalk, Conn) or Hem-o-Lok clips have been used to secure the renal vessels. But the use of staplers or Hem-o-Lok clips across an early bifurcation of a single renal stump results in two separate vessels. Various techniques have been described in the literature for reconstruction of double vessels before transplantation.[10]

Analysis of our data revealed that the mean operative time for laparoscopy group I was 166.3 ± 49.1 minutes, which was less than reported by Gurkan *et al.*[11](247 ± 7.2 minutes) and Singh *et al.*[12] (210 minutes). Shorter operative time in our series may be attributed to the fact that a single experienced laparoscopic surgeon performed all LDN. Overall, warm ischemia time was 5.6 ± 1.8 minutes for single-vessel donors, compared with 7.2 ± 1.9 minutes in those with double vessels; warm ischemia time was comparable to that seen in LDN by Gurkan *et al.*[11] Singh *et al.*[12] from the Cleveland Clinic reported a warm ischemia time of 4 minutes, which was significantly less than in our series. Although the creatinine level at day 1 was higher in group I than in the other groups, the differences in creatinine at 1 month and 1 year were not statistically significant. Mean creatinine level at the end of 1 year was 1.2 ± 0.4 mg/dL, similar to that reported by Singh *et al.*[12] and Gurkan *et al.*[11]

One-year graft survival in groups I, IIA, and IIB was 92%, 94.4%, and 94%, respectively, comparable to that reported in published series.[11,13]

For the single renal artery recipients, vascular complications were observed in 4 (1 graft arterial thrombosis, 3 mycotic aneurysm). None of our recipients had renal artery stenosis. We ensure a wide arterial lumen for anastomosis by gentle arterial dilatation and spatulation of donor and recipient vessels.

The overall ureteric complication rate was 1.5%, much less than that reported by Jacobs *et al.*[5] None of the recipients had ischemic ureteric strictures. Shalhav *et al.*[14] compared manual bag extraction with endocatch bag extraction and found that manual extraction was superior to bag retrieval. We retrieve the graft by manual extraction through a preplaced pfannenstiel incision.

We believe that LDN is now an acceptable procedure for graft procurement. It is safe even in cases of multiple vessels.

CONCLUSIONS

Although the presence of double renal vessels or early branching poses a technical challenge for laparoscopic LDN, the procedure is feasible and safe. In our study no bleeding complications were observed in donors with multiple vessels. Although the serum creatinine level was higher in the multiple-vessel group at day 1, at 1 month and 1 year the difference was not statistically significant. Moreover, the overall graft outcome was similar in all groups.

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