Original Article

Surgical Aspects and Outcomes of Kidney Transplantation with Multiple Renal Arteries

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Aim: To evaluate the effect of multiple renal artery presence on the success and complication rate of renal transplantation.

Patients and Methods: Between January, 1990 and June 2008, 1250 live donor kidney transplants were included in the study. Among the 1250 kidney transplants, there were 930 males and 320 females. We divided the study population in two groups according to their vascular reconstruction: Group A: 1130 grafts with a single artery. Group B: 120 grafts with multiple arteries. Intracorporeal in situ anatomotic techniques were used for 100 grafts with multiple arteries, while ex-vivo anastomotic techniques were used for 20 patients. We compared the incidence of post transpolant hypertension, acute tubular necrosis, acute rejection, vascular and urological complications, mean creatinine level at 1 and 5 years post transplant and patient and graft survival.

Results: The patient and graft survival were comparable in group A and group B. The two groups were omparable regarding complication, including arterial bleeding, hematoma, renal artery stenosis, acute rejection, new onset hypertension, acute tubular necrosis and urological complications. Mean serum creatinine at 1 year was higher in group B than in group A (1.6 + 0.7 versus 1-3 + 0.5 mg/dl). However, this mean serum creatinine level was comparable in two groups at 5 years. Graft and patient survival and the incidence of the described complication were comparable for the ex vivo bench anastomotic techniques and intracorporeal in situ technique in group with multiple renal arteries.

Conclusions: Although the kidney grafts with multiple renal arteries have been considered a relative contraindication because of increase risk of complications, allografts with multiple arteries were used successfully in kidney transplantation in our study. No significant difference has been observed between single and multiple renal arteries kidneys considering the success and complication rates of renal allotransplantation.

Key words: Transplantation; Renal transplantation; arteries.

Introduction

Renal transplantation is the treatment of choice for the vast majority of the patients with end stage renal disease[1]. Considerable progress has been made in surgical techniques over the past three decades. The graft and patient outcome has significantly improved because of standardization in surgical technique and refinements in immunosuppressive therapy, organ preservation and antimicrobial therapy.[2] However, grafts with anatomic variants are still challenging problems to the surgeons. Of these variants, multiple renal arteries are the most common. Multiple renal arteries are found in 18% to 30% of all potential kidney donors[3]. The use of these grafts with multiple renal arteries has been considered a relative contraindication because of increased incidence of vascular and urological complications[4]. Now several surgical and microsurgical methods of intracorporeal and ex vivo surgeries have been used to transplant grafts with multiple renal arteries.[4,5] In this present study, we report our experience with live donor renal transplantation with multiple arteries regarding different surgical techniques, outcomes and related vascular, urological and medical complications.

Materials and Methods

Between January, 1990 (when our renal transplant programme was begun) and June 2008, 1250 live donor kidney transplants were included in this study. Among the 1250 kidney transplants, there were 930 males and 320 females. The mean age + S.D was 28.5 + 11.0 years for the recipients (range 10 – 65). The mean age + S.D was 35.0 +8.5 years (22 – 60). We divided the study population in two groups according to their vascular reconstruction.

Group A: 1130 grafts with a single artery.
Group B: 120 grafts with multiple arteries.

The donor renal vein was anastomosed to the recipient's external iliac vein by end-to-side anastomosis in the majority of the cases. The common iliac vein was used in children.

In Group A, the renal artery was anastomosed to the internal iliac artery by end-to-end anastomosis technique in 1115 patients. In the remaining 115 recipients of group A, arterial anastomosis was formed end to side to the external iliac artery and common iliac artery in 110 and 05 patients respectively.

In Group B, the 120 grafts with multiple arteries, 110 has 02, 08 had 03 and 02 had 04 arteries. Intracorporeal in situ anastomotic techniques were done in 100 patients. In these 100 patients, Table 1 list the sites of anastomosis of the first and second arteries. In 06 patient receiving a graft

with three arteries, the anastomosis of the third artery was formed to a branch of the internal iliac artery in 05 and to the external iliac artery in 01.

Microvascular anastomotic techniques were used in 20 cases, including 15 with 2, 04 with 3 and 1 with 4 renal arteries. In 15 grafts, the arteries were anastomosis side to side each other. The common stem was anastomosed to the internal iliac artery using all end to end technique in 10 grafts and to the external iliac and common iliac arteries and aorta using an end to side technique in 2, 2 and 1, respectively. In the 4 grafts with 3 arteries side to side anastomosis of the 2 main arteries was done ad followed by end-to-end anastomosis of the common stem to the internal iliac artery. The third artery was then anastomosis separately to the external iliac artery by end to side technique. In a graft with 4 arteries, the two arteries were anastomosied to make 2 common stem, one of these common stem was anastomosed to the internal iliac artery by end to end are the 2nd common stem was anastomosed to the external iliac artery by end-to-side method. Lastly, the ureter was reimplanted into the bladder by modified Lich's technique.

Postoperative, Doppler ultrasonography was performed to document the successful revascularization of all areas in transplant with multiple renal arteries.

All these patients were treated with triple immunosuppression with cyclosporine (5mg/kg), Azathioprine (1.5-2 mg/Kg) and steroids. Initially melhylprednisolone was used followed by prednisoone (1 mg/kg). Later on, the prednisolone was tappered to 10 mg/kg. cyclosporine doses were adjusted according to drug blood levels. Dosage adjustments of azathioprine was made according to the while cell count and clinical picture.

Group A and B were compared regarding patient and graft survival, early and late vascular complications, early and late urological complications, incidence of acute tubular necrosis, acute rejection and new onset post-transplantation hypertension. In group B ex vivo and intracorporeal techniques were compared regarding the described complications. In addition end-to-end and end-to-side anastomotic techniques were compared in the one way. For statistical comparisons, the Pearsau and Chi-Square tests and Kaplan-Meir curves were used.

Results

In this present study, we have compared the patient and graft survival in the two groups. One and five year graft survival was 93% and 78% in group-A and 95% and 73% in group-B (P = 0.89). One and five year patients survival was 93% and 85% in group A and 96% and 88% in group B patients respectively. Further analysis of survival data also failed to show any statistical difference between the two groups.

The results of comparing the two groups regarding incidence of some relevant complications are shown in Table 2. Group A and group B were comparable regarding the incidence of early and late vascular complications. The incidence of post transplant hypertension was higher in group B than in group A at 3 months. However, the incidence of new onset hypertension was comparable in two groups.

Table 1: *The site of anastomosis of individual arteries in in-situ anastomotic techniques.*

Parameter	**No. of Grafts**
Anastomotic site donor of renal artery 1: Recipient internal iliac artery	85
Recipient external iliac artery	10
Recipient common iliac artery	05
Anastomotic site of renal artery 2: Recipient internal iliac artery	40
Recipient external iliac artery	50
Recipient common iliac artery	10
Anastomotic site of renal artery 3: Internal iliac artery	05
External iliac artery	01

The ischemia time was significantly longer in group B than group A (P< 0.001). However this was not reflected in the incidence of acute tubular necrosis.

As a measure of graft function, we compared mean creatinine values among the two groups i.e. the values at 1 and 5 year post transplant. Mean serum creatinine at 1 year was higher in the group B than in group A (1.6 + 0.7 versus 1.3 + 0.5 mg/dl). However the mean serum creatinine level was comparable in two groups at 5 year. We evaluated the factors responsible for higher serum creatinine at 1 year in group B. It was found that multiple renal arteries, acute tubular necrosis, pretransplant hypertension and new onset hypertension had a significant impact on mean serum creatinine at 1 year.

The rate of urological complications is shown in Table 2. We found no difference in regarding the incidence of ureteral obstruction, late strictures and anastomotic or bladder leak among these two groups. Complications of lower polar artery or calyceal cutaneous fistulas, were not observed in any groups.

The site of arterial anastomosis into the internal iliac artery (end-to-end), or to the external or common iliac artery, or aorta (end to side) had no significant impact on the incidence of vascular complications, new onset hypertension or mean serum creatinine at 1 and 5 years.

The incidence of acute tubular necrosis was significantly higher when the external or common iliac artery, or aorta was used for arterial anastomosis (end- to- side) than when end-to-end anastomosis was formed to the external iliac artery.

Table 3 shows multiple artery group comparison of intracorporeal in situ and ex-vivo bench techniques of arterial anastomosis. It was found that there was no significant difference regarding the incidence of the described complications between ex-vivo and intracorporeal anastomotic techniques in the group with multiple arteries. However, it was observed the mean ischemia time needed to form the actual anastomosis in the patient was significantly longer for the intracorporeal techniques than for ex vivo techniques (70 + 10 versus 30 + 5 minutes).

Table 2: *Comparison of relevant complications in grafts in Group A with single renal artery and group B with multiple renal arteries.*

Complication	Group A (No. of pts/total No. (%)	Group B (No. of pts/total No. (%)
Arterial bleeding	8/1130 (0.7)	2/120 (1.66)
Hematoma	12/1130 (1.06)	3/120 (2.5)
Renal artery stenosis	8/1130 (0.7)	1/120 (0.83)
New onset hypertension	550/1130 (48.67)	55/120 (45.8)
Urological complications	95/1130 (8.4)	10/120 (8.3)
Mean ischemia time	+ SD (mins) 40.5 + 10.2	55 + 13
Acute tubular necrosis	50/1130 (4.4)	5/120 (4.1)
Serumcreatinine 1.5 mg/dl on groups: or greater at 1 year	260/950 (27.4) 240/550 (43.6)	40/100 (40) 22/45 (48.8)

Discussion

According to several large autopy series, the incidence of multiple renal arteries ranges between 18% to 30%. The incidence in our patient population with renal transplant was 9.6%.[6,7]

Transplant grafts with multiple renal arteries have several theoretical disadvantages. Anastomosis time is prolonged and more difficult, potentially increasing the risks of acute tubular necrosis and graft rejection. Technical difficulty with renal arterial anastomosis can lead to infarction of a graft, segment, infection, calyceal fistula or ureteral necrosis, all of which translate to increased morbidity and higher rates of graft loss.[2,8,9]

Table 3: *Comparison of intracorporeal in situ and ex vivo bench techniques of arterial anastomosis in multiple artery group B patients.*

Complication	No in situ/ total No. (%)	No Ex vivo/ total No. (%)
Arterial bleeding	3/100 (3)	1/20 (5)
Hematoma	2/100 (2)	1/20 (5)
Renal artery stenosis	0	0
New onset hypertension	45/100 (45)	14/20 (70)
Urological complications	10/100(10)	2/20 (10)
Acute tubular necrosis	4/100 (4)	3/20 (15)
Serum creatine 1.5 mg/dl or greater 1 year	35/100 (35)	9/20 (45)

In cadaveric kidney grafts the Carrel aortic patch represents a good method for anastomosing multiple renal arteries end to side with the recipient external iliac artery. However, this technique is not applicable to live donor population. In addition, sometimes the Carrel aortic patch is not obtained or the origin of arteries are remote from each other in cadaveric renal transplantation. In these situation, several in situ intracorporeal or more recently ex vivo microvascular anastomotic techniques have been used to engraft kidney with multiple renal arteries. In situ techniques include the use of various branches of the recipient hypogastric artery, a combination of hypogastric and external iliac arteries, multiple individual end-to-end anatomosis to the external iliac artery and even the inferior epigastric artery. On the other hand, main objective of ex vivo microvascular techniques, as popularized by Novick, is to create a single arterial ostium to facilitate vascular anastomosis in situ with maximum accuracy and minimal warm ischemic damage to kidney.[9-11]

In kidney transplants with multiple anastomosis, revascularization can be done either simultaneously after the entire arterial engraftment is completed or sequentially. Using the latter technique, the main renal artery is revascularized first. Then, the vascular clamps are released and the kidney is partially revascularized. The other artery is anastomosis to a convenient site, maintaining perfusion of the kidney by the main artery. We did not find any difference between simultaneous and sequential revascularization in regard to the incidence of ATN or any other complication.[2,12,13]

In our series, we found no difference in short and long term kidney graft outcomes based a number of renal arteries at the technique used for reconstruction and anastomosis. Graft survival was excellent with multiple anatomosis and with multiple arteries converted to single artery by bench reconstruction.[14,15]

The increased rate of vascular complications in association with renal transplantation incorporating multiple arteries is a matter of controversy. Some investigations have concluded that graft, with multiple arteries are associated with a higher incidence of vascular complications than those with single arteries.[4,12,13,16] In our study as well as in others, there was no association between multiple cites of the renal

artery and an increased risk of vascular complication. Although an increased incidence of urological complications was reported in association with this group of renal transplants in earliers studies, recent publications did not show this effect.[1,4,8-10]

Ischemia time was significantly longer in the multiple artery groups than in the single artery group. However, it was not reflected in the incidence of acute tubular necrosis in our study. This observation is in accordance with the results of other studies.[12.18]

We noted higher mean serum creatinine at 1 year in the multiple artery than in single artery graft, a finding not observed in other studies. It was not maintained at 5 years in our series. In our opinion this finding is attributable to significantly longer ischemia time in the group B with multiple arteries. The Canadian transplant study group reported that long vascular anastomotic time (more than 45 minutes) adversely influences allograft function but not survival at 1 year.[12,18]

The initial iliac artery was extensively used for arterial anastomosis in our study because most of our patients were young and the interruption of one hypogatic artery has not been associated with penile vascular insufficiency or impotence. The external iliac artery common iliac artery, or aorta is only used sparingly in children.

In addition, external iliac artery is used for retransplant if the internal iliac artery was the site of anastomosis in the first transplant, and if atheroclerosis or other disease affect the internal Iliac artery. There was no difference between the group in which the internal iliac artery was the main artery for anastomosis and the other group in which external iliac was used. However, if renal artery thrombosis developed with extension to the external iliac artery in a single case of transplantation to be external iliac artery, a catastrobic complication would occur. Although the incidence of new onset hypertension was comparable in the single and multiple artery group in our study, a difference of marginal significant was noted for the extracorporeal and intracorporeal techniques of arteries anastomosis ($p<0.04$).[18-20]

Conclusion

Live donor renal allograft with multiple renal arteries does not adversely affect patient or graft survival compared with single renal artery group. Multiplicity of the renal arteries in live donor renal allotransplantation is not associated with a higher rate of complications in single artery group except high mean serum creatinine at 1 year. Multivariate analysis showed that multiplicity of renal arteries had an adverse impact on mean creatinine at 1 year. However, the effect was not maintained at 5 years. The site of anastomosis of the renal artery into the internal or external arteries had no significant effect on the incidence of relevant complication. However, acute tubular necrosis developed more frequently when the external common iliac artery, a aorta was used. Extracorporeal bench surgery was as effective as intracorporeal surgery for anastomosis of multiple renal arteries with increase in the incidence of related complications. These findings indicate that kidney grafts with multiple arteries can be used with excellent results.

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