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Impact of Arterial Reconstruction With Recipient's Own Internal Iliac Artery for Multiple Graft Arteries on Living Donor Kidney Transplantation

Strobe Study

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Abstract: The aim of this study is to investigate the usefulness of arterial reconstruction using the recipient's own internal iliac artery for multiple kidney graft arteries.

The safety and efficacy of various arterial reconstruction methods have been demonstrated. Although some reports have documented arterial reconstruction with the recipient's own internal iliac artery for multiple kidney graft arteries using the interposition method, usefulness of this technique has not yet been investigated compared with other arterial reconstruction methods.

Between January 2008 and April 2014, 532 living donor kidney transplants in adult recipients were performed at 1 center. Of these, 389 kidney grafts had a single artery and did not need arterial reconstruction (nonarterial reconstruction group). Among the bench surgery patients, 19 kidney grafts for multiple arteries were performed using the interposition method with the recipient's own internal iliac artery (interposition group). Seventy-nine kidney grafts were performed using conjoined reconstruction (conjoined group) and 15 kidney grafts were performed using end-to-side reconstruction (end-to-side group). Total ischemic time (the period between arterial clamp and blood reperfusion), time to initial urination (the period between blood reperfusion and urination from the graft ureter), perioperative and postoperative estimated glomerular filtration rate (eGFR), and complication rates between the interposition group and other 3 groups were retrospectively investigated. This study was based on the STROBE compliant.

Warm ischemic time (the period between arterial clamp and beginning of the cold perfusion) of interposition group was significantly longer than that of nonarterial reconstruction group. Total ischemic time of the interposition group was significantly longer than those of other 3 groups. But time to initial urination, perioperative and postoperative eGFR, and complications were similar to other 3 groups.

The interposition method was shown to be a useful standard method for multiple kidney graft arteries of living donor kidney transplantation in carefully selected recipients without calcification of the iliac arteries.

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Abbreviations: 95% CI = 95% confidence interval, BMI = body mass index, eGFR = estimated glomerular filtration rate.

INTRODUCTION

The first laparoscopic donor nephrectomy was reported by Ratner et al in 1995.¹ Wolf et al introduced hand-assisted laparoscopic donor nephrectomy in 1998.² Since then, laparoscopic procedures have been widely performed for living donors. Previously, some reports did not recommend laparoscopic procedures for the donors of multiple graft arteries due to the frequent complications.^{3,4} Nevertheless, now several reports have addressed the operative indications of laparoscopic procedures for the donors of multiple graft arteries.⁵⁻⁷ However, graft arterial length is shorter with laparoscopic procedures than with open procedures because of the wide endostaple lines. Kidney grafts with early branched arteries often lead to multiple arteries after the removal of staples. For these multiple arteries, arterial reconstructions were necessary. Many techniques of arterial reconstruction have been reported, such as the conjoined method, the end-to-side method, and the method involving the inferior epigastric artery. The efficacy and safety of these methods has also been reported before.⁸ Only the operative technique of arterial reconstruction with the recipient's own internal iliac artery for multiple arteries (interposition method) has likewise been reported,⁹⁻¹² but the usefulness of this method compared with that of a single arterial graft, conjoined method, and end-to-side method has not yet been demonstrated. In this study, we investigated the usefulness of interposition methods compared with that of a single arterial graft (nonarterial reconstruction), conjoined method, and end-to-side method.

METHODS

Study Design

To investigate the usefulness of the interposition method, adult recipients of living donor kidney transplants were divided into 4 groups according to the operative methods used. One was the interposition group and the others were nonarterial reconstruction group, conjoined group, and end-to-side group. Usefulness between interposition group and other 3 groups was

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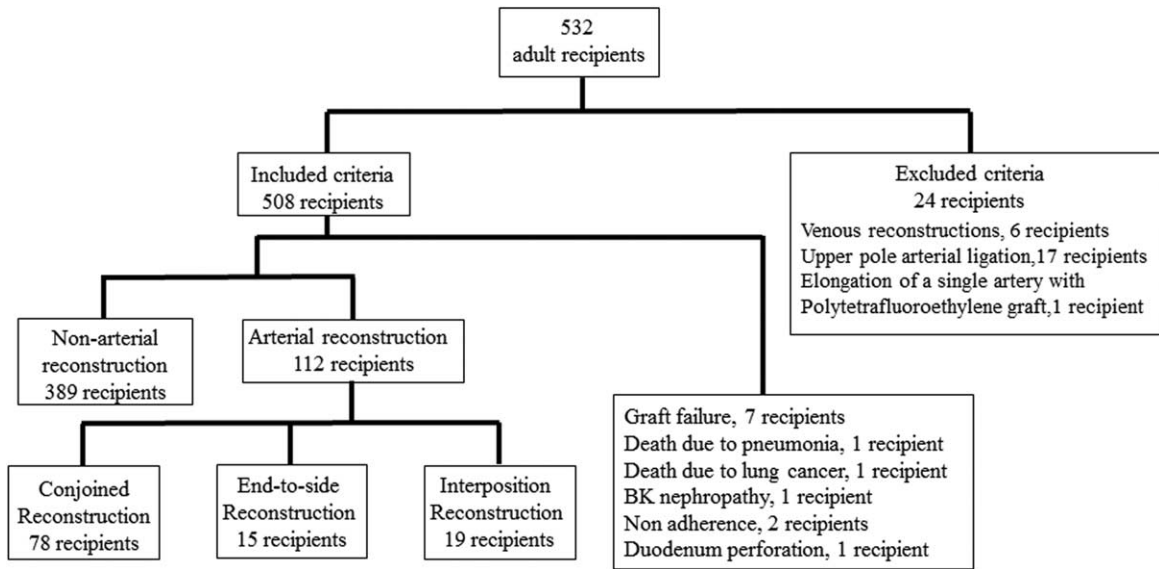


FIGURE 1. SRTOBE flow chart.

evaluated with perioperative and postoperative estimated glomerular filtration rate (eGFR), and complications.

Participants

Between January 2008 and April 2014, 532 consecutive living donor kidney transplants were performed in adult recipients at our hospital. Of these, 24 were excluded from this study due to the following reasons: 1 out of 24 underwent elongation of a single artery with polytetrafluoroethylene graft, 6 underwent venous reconstruction, and very thin arteries feeding the upper pole were ligated in 17. The remaining 508 recipients were enrolled in the study and observed every month from January 2008 to September 2014 (mean observation period: 41.9 ± 21.3 months) (Fig. 1). All patients' data were retrospectively collected from patients' charts without missing data.

Ethical Review

This study was approved by the institutional review board in Nagoya Daini Red Cross Hospital.

Outcome Measures

Total ischemic time (TIT) (the period between arterial clamp and blood reperfusion), time to initial urination (the period between blood reperfusion and urination from the graft ureter), perioperative and postoperative estimated glomerular filtration rate (eGFR), and complications were compared. Complications included arterial thrombosis, urine leakage, ureteric stricture, delayed graft function, postoperative bleeding, lymphocele, acute cellular rejection, and antibody-mediated rejection.

Preoperative Evaluation and Indication of Interposition Method

Preoperative kidney functions and anatomical features were evaluated with Tc-99m diethylene-triamine-pentaacetate and enhanced CT images. Procurement side was determined according to kidney function and donor kidney problems, such as renal stones and arterial aneurysms, regardless of the number of renal arteries. The number of kidney graft arteries was evaluated

preoperatively with enhanced 3D-CT images. The condition of the recipient's iliac artery was also evaluated with CT images. For the recipients without calcified iliac arteries, interposition method was selected. Conjoined method and end-to-side method were the first choice for arterial reconstruction, if the arterial length and distance between arteries were appropriate. However, if arterial conditions were not appropriate for conjoined method and end-to-side method, interposition method was then selected.

Interposition Methods

Before bench surgery, the recipient's internal iliac artery was exposed to the peripheral branches of the anterior and posterior branch. After ligating the peripheral branches of the anterior and posterior branch, the internal iliac artery was clamped. The internal iliac artery was cut at the peripheral branches of the anterior and posterior branch and in the middle of the internal iliac artery. Next, the arterial graft was procured. In bench surgery, each artery of kidney graft was anastomized end-to-end with each peripheral branch of the internal iliac artery. The kidney graft was then implanted by reanastomosis of the internal iliac artery (Fig. 2).

Statistical Analysis

Statistical analyses were performed using the independent-samples *t* test for continuous data, and χ^2 or Fisher exact test for the categorical variables; $P < 0.05$ was considered significant. Analyses were performed using SPSS for Windows version 13.0 (IBM, Chicago, IL) statistical software.

RESULTS

Participants

Five hundred eight recipients were enrolled in the study and observed every month from January 2008 to September 2014 (mean observation period: 41.9 ± 21.3 months). During the observation period, 7 patients dropped out for the following reasons: 2 with functioning grafts died due to lung cancer and pneumonia, 1 developed BK virus nephropathy, 2 experienced

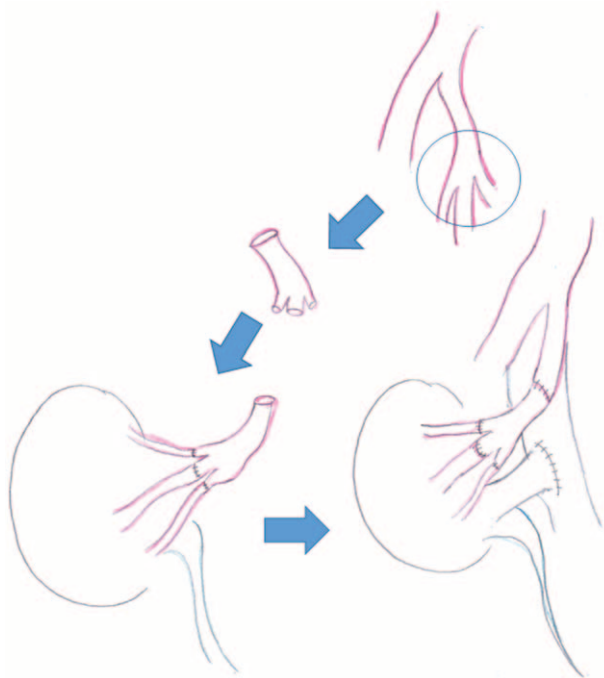


FIGURE 2. Operation technique of arterial reconstruction with recipient's internal iliac artery for multiple kidney graft arteries (interposition method).

acute cellular rejections due to nonadherence, and 1 developed graft loss due to perioperative duodenal perforation. As a result, 501 of the 532 recipients were observed at our hospital; no patients dropped out during this period. Three hundred eighty-nine out of 501 kidney grafts had a single artery and did not need arterial reconstruction (nonarterial reconstruction group). The interposition method was performed in 19 kidney grafts (interposition group). Conjoined method (conjoined group) and end-to-side method (end-to-side group) were performed in 78 and 15 kidney grafts, respectively (Fig. 1).

Descriptive Data

Characteristics of recipients, donors, and kidney grafts for the interposition group (19 recipients), conjoined group (78 recipients), end-to-side group (15 recipients) and the non-arterial reconstruction group (389 recipients) were shown in Table 1. There was no significant difference between interposition group and other 3 groups except for the number of arteries (Table 2). Kidney grafts with more than 2 arteries were significantly more in interposition group than those of other 3 groups. All patients' data collected were complete and accurate.

Main Results

The results of the surgeries were investigated. Warm ischemic time (WIT) (the period between arterial clamp and beginning of the cold perfusion), TIT, time to initial urination and complications were shown in Table 3. WIT in interposition group was significantly longer than that of nonarterial reconstruction

TABLE 1. Characteristics of Recipients, Donors, and Kidney Grafts

	Interposition Group	Conjoined Group	End-to-Side Group	Non-arterial Reconstruction Group
Numbers	19	78	15	389
BMI: body mass index recipients				
Sex (male/female)	9 (47.4%)/10 (52.6%)	49 (62.8%)/29 (37.2%)	6 (40.0%)/9 (60.0%)	246 (63.2%)/143 (36.8%)
Age (mean ± SD) (yr)	45.3 ± 14.0	50.1 ± 12.6	51.6 ± 13.1	46.6 ± 13.9
BMI (mean ± SD) (kg/m ²)	22.7 ± 3.4	22.5 ± 4.5	21.0 ± 3.5	22.2 ± 3.8
Preemptive kidney transplant	10 (52.6%)	27 (34.6%)	6 (40.0%)	139 (35.7%)
Donors				
Sex (male/female)	7 (36.8%)/12 (63.2%)	27 (34.6%)/51 (65.4%)	6 (40.0%)/9 (60.0%)	123 (31.6%)/266 (68.4%)
Age (mean ± SD) (yr)	61.0 ± 6.4	61.4 ± 10.1	63.9 ± 9.3	59.0 ± 10.5
BMI (mean ± SD) (kg/m ²)	22.7 ± 2.9	22.8 ± 2.7	22.0 ± 1.8	22.8 ± 5.5
eGFR (mean ± SD) (mL/min/1.73 m ²)	73.8 ± 15.2	74.7 ± 16.9	74.2 ± 17.2	75.4 ± 13.3
Kidney grafts				
Weight (mean ± SD) (g)	181.4 ± 43.3	168.6 ± 42.6	177.5 ± 40.4	174.5 ± 38.8
Arterial numbers				
1	0	0	0	389 (100%)
2	10 (52.6%)	76 (97.4%)	14 (93.3%)	0
3	9 (47.4%)	2 (2.6%)	1 (6.7%)	0

BMI = body mass index.

TABLE 2. Characteristics of Recipients, Donors, and Kidney Grafts

	Interposition Group Vs Conjoined Group		Interposition Group Vs End-to-Side Group		Interposition group vs. Non-arterial reconstruction group	
	P Value	95% CI	P Value	95% CI	p value	95% CI
Recipients						
Sex	0.198	−0.086 to 0.412	0.679	−0.074 to 0.176	0.190	−0.075 to 0.375
Age	0.144	−1.693 to 11.401	0.189	6.337 to 4.717	0.683	−5.075 to 7.737
BMI	0.875	−2.376 to 2.027	0.149	−1.745 to 1.182	0.535	−2.321 to 1.206
Preemptive kidney transplant	0.126	0.746 to 5.677	0.350	0.423 to 6.562	0.107	0.199 to 1.261
Donors						
Sex	0.162	−0.423 to 0.072	0.479	−0.126 to 0.176	0.138	−0.391 to 0.054
Age	0.885	−4.497 to 5.205	0.286	2.933 to 2.701	0.209	−5.285 to 1.222
BMI	0.989	−1.401 to 1.422	0.415	−0.706 to 0.855	0.954	−2.412 to 2.559
eGFR	0.839	−7.554 to 9.278	0.942	0.406 to 5.556	0.605	−4.570 to 7.836
Kidney grafts						
Weight	0.258	−34.950 to 9.474	0.792	−3.908 to 14.686	0.467	−25.361 to 11.652
Arterial numbers						
≥3	<0.001	6.365 to 178.965	0.011	1.369 to 115.971	<0.001	0.014 to 0.046

95% CI = 95% confidence interval.

group. TIT in interposition group was also significantly longer than those of other 3 groups. However, there was no significant difference in each complication (Table 4). Perioperative and postoperative graft function in interposition group was similar to those of other groups (Fig. 3, Table 5).

DISCUSSION

It has been reported that more than 2 arteries are found in the unilateral kidneys of 18% to 30% of the potential donors and in the bilateral kidneys of 15% of the potential donors.¹³ Laparoscopic donor nephrectomy has recently been common,

but it sometimes leads to short arteries and more than 2 arteries. This might be due to the wide endostaple lines and angle limitation of the endostapler. For these grafts, arterial reconstructions are necessary before transplantation. For the grafts with renal arterial aneurysms, resections of aneurysms, and arterial reconstructions are also required.^{14–16} Reconstructions of accessory arteries to the lower pole are reported to be important to avoid ureteral complications.¹⁷

Some studies have noted inferior outcomes in multiple graft arterial reconstructions compared with those in a single graft artery.^{3,4,14} Ureteral complications and vascular complications were significantly higher in recipients of multiple arterial grafts.

TABLE 3. Outcomes of Operation

	Interposition Group	Conjoined Group	End-to-Side Group	Non-arterial Reconstruction Group
Numbers	19	78	15	389
Warm ischemic time (mean ± SD) (s)	215.3 ± 127.4	165.1 ± 62.3	157.3 ± 38.9	136.4 ± 40.0
Total ischemic time (mean ± SD) (min)	181.4 ± 43.3	125.2 ± 33.0	140.7 ± 48.0	93.0 ± 36.9
Initial urination (mean ± SD) (min)	18.1 ± 10.1	23.8 ± 25.4	20.1 ± 14.2	20.2 ± 18.9
Complications				
Arterial thrombosis	0	1 (1.3%)	0	2 (0.5%)
Urine leakage	0	1 (1.3%)	0	4 (1.0%)
Ureteric stricture	0	1 (1.3%)	0	3 (0.8%)
Delayed graft function	0	1 (1.3%)	0	0
Bleeding	0	1 (1.3%)	0	6 (1.5%)
Lymphocele	0	1 (1.3%)	1 (6.7%)	3 (0.8%)
Acute cellular rejection	0	0	0	2 (0.5%)
Antibody mediated rejection	0	1 (1.3%)	0	6 (1.5%)

TABLE 4. Outcomes of Operation

	Interposition Group Vs Conjoined Group		Interposition Group Vs End-to-Side Group		Interposition group vs. Non-arterial reconstruction group	
	P Value	95% CI	P Value	95% CI	p value	95% CI
Warm ischemic time	0.111	-112.931 to 12.509	0.074	-57.996 to 30.912	0.015	-140.393 to 17.348
Total ischemic time	<0.001	-78.303 to 43.017	0.006	-45.109 to 15.282	<0.001	-109.948 to 75.653
Initial urination	0.338	-6.097 to 17.571	0.632	2.014 to 4.167	0.617	-6.388 to 10.758
Arterial thrombosis	0.802	0.723 to 0.885	-	-	0.909	0.933 to 0.974
Urine leakage	0.802	0.723 to 0.885	-	-	0.826	0.933 to 0.974
reteric stricture	0.802	0.723 to 0.885	-	-	0.866	0.933 to 0.974
Delayed graft function	0.802	0.723 to 0.885	-	-	0.826	0.933 to 0.974
Bleeding	0.802	0.723 to 0.885	-	-	0.750	0.932 to 0.974
Lymphocele	0.802	0.723 to 0.885	0.441	0.285 to 0.631	0.866	0.933 to 0.974
Acute cellular rejection	-	-	-	-	0.909	0.933 to 0.974
Antibody mediated rejection	0.802	0.723 to 0.885	-	-	0.750	0.932 to 0.974

95% CI = 5% confidence interval.

Likewise, lymphoceles were more frequently reported in the recipients of multiple arterial grafts.¹⁸ Graft survival in recipients of a single arterial graft was significantly better.⁴

On the other hand, several reports have noted the safety and efficacy of arterial reconstruction for multiple arteries.^{11,19,20} In these reports, arterial reconstructions for multiple arteries were performed with multiple end-to-side anastomoses to the external iliac artery, conjoined anastomosis, and end-to-side anastomosis to the main branch of the graft artery.¹⁹ Outcomes of graft function, graft survival, and complications were similar in recipients of either single or multiple arterial grafts.^{3,5,19,21} However, even in these reports, the interposition method was not discussed closely. Only operative techniques of hypogastric arterial reconstruction and interposition method have been discussed in some reports,⁹⁻¹² but there has been no reports demonstrating the usefulness of the interposition method.

For a successful interposition procedure, preoperative evaluations in both donors and recipients are necessary. Initially, the number of arteries of kidney graft was evaluated with enhanced 3D-CT images. For recipients of multiple kidney graft arteries, CT images of the recipients' internal iliac artery should be also closely evaluated. Interposition method can be selected for the recipients without calcified internal iliac arteries, because calcification of an internal iliac artery might inhibit the safe of anastomosis and lead to arterial stenosis in the future. For recipients with a calcified internal iliac artery, other procedures such as multiple end-to-side anastomoses to the recipients' external iliac arteries should be selected.

Characteristics of recipients, donors, and kidney grafts were similar between the interposition group and the other groups except for the arterial number. Interposition method was dominantly selected for the kidney grafts with more than

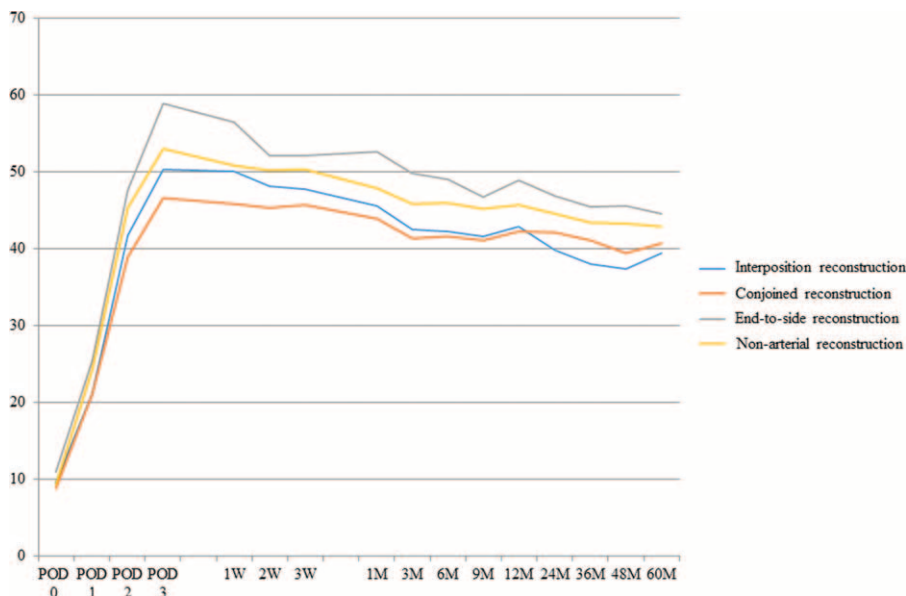


FIGURE 3. Mean estimated glomerular filtration rate of the recipients during the observation period. There was no significant difference between the 2 groups throughout the perioperative and postoperative periods.

TABLE 5. Perioperative and Postoperative Graft Function

	POD 0	POD 1	POD 2	POD 3	1W	2W	3W	1M	3M	6M	9M	12M	24M	36M	48M	60M	
Interposition group vs conjoined group	P value	0.989	0.526	0.420	0.281	0.427	0.562	0.598	0.728	0.819	0.873	0.832	0.514	0.348	0.587	0.819	
	95% CI	-2.301 to 0.707	-11.519 to 5.928	-13.067 to 5.490	-12.060 to 3.544	-9.768 to 4.166	-8.814 to 4.820	-7.639 to 4.424	-7.557 to 5.299	-6.834 to 5.417	-6.631 to 5.641	-6.930 to 5.590	-4.725 to 9.346	-3.461 to 9.629	-5.665 to 9.839	-11.010 to 13.733	
Interposition group vs end-to-side group	P value	0.264	0.325	0.188	0.266	0.470	0.438	0.114	0.080	0.139	0.258	0.173	0.076	0.076	0.066	0.386	
	95% CI	-1.095 to 3.867	-3.078 to 17.814	-6.084 to 21.383	-5.077 to 17.810	-6.965 to 14.777	-6.983 to 15.752	-1.787 to 15.917	-0.924 to 15.582	-2.318 to 15.862	-2.318 to 15.862	-3.934 to 14.158	-2.784 to 14.866	-0.770 to 14.701	-0.840 to 15.877	-0.580 to 17.031	-7.401 to 17.694
Interposition group vs nonarterial reconstruction	P value	0.553	0.377	0.549	0.855	0.578	0.499	0.498	0.308	0.238	0.236	0.360	0.155	0.102	0.185	0.548	
	95% CI	-1.845 to 0.989	-4.412 to 11.619	-6.068 to 11.392	-7.099 to 8.556	-5.328 to 9.545	-4.880 to 9.999	-4.358 to 8.956	-3.124 to 9.877	-2.449 to 9.830	-2.449 to 9.830	-3.180 to 9.529	-1.794 to 11.203	-1.092 to 12.034	-2.879 to 14.814	-7.958 to 14.898	

95% CI = 95% confidence interval, POD = postoperative day.

3 arteries. This meant that interposition method was more applicable in kidney grafts with more than 2 arteries than conjoined method and end-to-side method. And similar outcomes of operative factors, including complications could support this fact. Although arterial thrombosis, ureteric complications, and lymphocele were reported to be more frequent in the multiple arterial reconstruction group, in the present study, these complications did not significantly increase in interposition group compared with conjoined, end-to-side and nonarterial reconstruction groups. WIT in interposition group was similar to conjoined and end-to-side group, but significantly longer than nonarterial reconstruction group. It was because the endostapling of multiple arteries took more time. TIT in interposition group was more time consuming than those in the other 3 groups because of multiple anastomoses in bench surgery. However, these longer WIT and TIT did not affect early graft function, which was evaluated by initial urination, delayed graft function, and perioperative eGFR. In addition, long-term outcome of eGFR in the interposition group was similar not only to those of the conjoined group and end-to-side group but also to that of the nonarterial reconstruction group. This fact was essential to confirm the stability of interposition method. The similar characteristics of recipients, donors, and kidney grafts among these groups strongly supported the rationale for the evaluation of graft function with perioperative and postoperative eGFR. These favorable results were because of the safe and easy technique of interposition method. Each graft artery was anastomosed end-to-end with each branch of the recipient's iliac artery, and bench surgery is conducive to performing these fine procedures. Re-anastomosis of the graft iliac artery with the graft iliac artery was also quite easy because the size of the graft iliac artery was the same.

One limitation of this method is the condition of the recipient's iliac artery. Severely calcified iliac arteries prevent this method and require the selection of a different approach. Another limitation is that the number of interposition group was not large in this study and further prospective investigations are expected.

In conclusion, arterial reconstruction with the recipient's internal iliac artery of multiple kidney graft arteries is a useful standard method for multiple kidney graft arteries of living donor kidney transplantation in carefully selected recipients without calcification of the iliac arteries.

REFERENCES

1. Ratner LE, Ciseck LJ, Moore RG, et al. Laparoscopic live donor nephrectomy. *Transplantation*. 1995;60:1047-1049.
2. Wolf JJ, Tchetgen M, Merion R. Hand-assisted laparoscopic live donor nephrectomy. *Urology*. 1998;52:885-887.
3. Carter JT, Freise CE, McTaggart RA, et al. Laparoscopic procurement of kidneys with multiple renal arteries is associated with increased ureteral complications in the recipients. *Am J Transplant*. 2005;5:1312-1318.
4. Paramesh A, Zhang R, Florman S, et al. Laparoscopic procurement of single versus multiple artery kidney allograft: is long-term graft survival affected? *Transplantation*. 2009;27:1203-1207.
5. Desai MR, Ganpule AP, Gupta R. Outcome of renal transplantation with multiple versus single renal arteries after laparoscopic live donor nephrectomy: a comparative study. *Urology*. 2007;5:824-827.
6. Hsu TH, Su Li, Ratner LE, et al. Impact of renal artery multiplicity on outcome of renal donors and recipients in laparoscopic donor nephrectomy. *Urology*. 2003;61:323-327.

7. Troppmann C, Wiesmann K, McVicar JP, et al. Increased transplantation of kidneys with multiple renal arteries in the laparoscopic live donor nephrectomy era: surgical technique and surgical and non-surgical donor and recipient outcomes. *Arch Surg.* 2001;136:897–907.
8. Antonopoulos IM, Yamacake KG, Oliveira LM, et al. Revascularization of living-donor kidney transplant with multiple arteries: long-term outcomes using the inferior epigastric artery. *Urology.* 2014;84:955–959.
9. Firmin LC, Johari Y, Nicholson ML. Explantation of the recipient internal iliac artery for bench-surgery during live donor renal transplants with multiple renal arteries. *Ann R Coll Surg Engl.* 2010;92:356.
10. Tchervenkov JI, Munda R. The use of the hypogastric artery in the anastomosis of multiple renal arteries in the transplant patient. *Transplant Int.* 1990;3:116–117.
11. Makiyama K, Tanabe K, Ishida H, et al. Successful renovascular reconstruction for renal allografts with multiple renal arteries. *Transplantation.* 2003;75:828–832.
12. Pan G, Chen Z, Liao D, et al. The application of the iliac artery in the ex vivo reconstruction of renal arteries in renal transplantation. *Transplantation.* 2010;89:1113–1116.
13. Roza AM, Perloff LJ, Naji A, et al. Living related donors with multiple renal arteries: a twenty years experience. *Transplantation.* 1989;47:397–399.
14. Kadotani Y, Okamoto M, Akioka K, et al. Management and outcome of living kidney grafts with multiple arteries. *Surg Today.* 2005;35:459–466.
15. Jung CW, Park KT, Kim MG. Experiences of renal transplantations from donors with a renal artery aneurysm after a laparoscopic donor nephrectomy and ex vivo reconstruction of renal artery. *Exp Clin Transplant.* 2013;11:324–326.
16. Toda F, Tanabe K, Ishikawa N, et al. Kidney transplantation from living donors with renal artery disease. *Transplant Proc.* 2000;32:1591–1592.
17. Kok NF, Dols LF, Hunink MG, et al. Complex vascular anatomy in live kidney donation: imaging and consequences for clinical outcome. *Transplantation.* 2008;85:1760–1765.
18. Mazzucchi E, Souza AA, Nahas WC, et al. Surgical complications after renal transplantation in grafts with multiple arteries. *Int Braz J Urol.* 2005;31:125–130.
19. Benedetti E, Troppmann C, Gillingham K, et al. Short and long term outcomes of kidney transplants with multiple renal arteries. *Ann Surg.* 1995;221:406–414.
20. Oh HK, Hawasli A, Cousins G. Management of renal allografts with multiple renal arteries resulting from laparoscopic living donor nephrectomy. *Clin Transplant.* 2003;17:353–357.
21. Basaran O, Moray G, Emiroglu R, et al. Graft and patient outcome among recipients of renal grafts with multiple arteries. *Transplant Proc.* 2004;36:102–104.