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Roles of Donor/Recipient Body Surface Area Ratio and Donor Kidney Glomerular Filtration Rate in Kidney Selection for Living Transplantation from Family Members

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ABSTRACT

Background: Accurate assessing donor renal function is crucial to the success of living kidney transplants. We studied the roles of donor kidney glomerular filtration rate (GFR) and donor/recipient body surface area (BSA) ratio in kidney selection for living transplantation from family members. **Methods:** We included 204 recipients who were subjected to living kidney transplantation from family members in our hospital from February 2011 to February 2015 and followed up for over 2 years. Recipients were divided into six groups according to donor GFR and donor/recipient BSA ratio. The effects of donor GFR or donor/recipient BSA ratio on the recovery of renal graft functions were evaluated. **Results:** The post-operative serum creatinine (S_{Cr}) reduction rate, steady-state S_{Cr} level, and estimated GFR (eGFR) of the group with donor GFR ≥ 40 ml/min were slightly higher to those of the group with donor GFR < 40 ml/min ($p > 0.05$). The renal function recovery of the group with donor/recipient BSA ratio ≤ 0.8 was significantly lower than that of the group with donor/recipient BSA ratio ≥ 1.2 ($p < 0.05$). The post-operative S_{Cr} reduction rate, steady-state S_{Cr} level, and eGFR of the group with GFR < 40 ml/min and donor/recipient BSA ratio ≤ 0.8 were all significantly lower than those of the other five groups ($P < 0.05$). Such values of the two groups with donor/recipient BSA ratio >1.2 were significantly higher than those of the other four groups ($p < 0.05$). **Conclusions:** The selection of donor kidneys from relatives for living kidney transplantation should also consider donor/recipient BSA ratio in addition to donor GFR. (REV INVES CLIN. 2018;70:169-76)

Key words: Glomerular filtration rate. Body surface area. Renal transplantation.

INTRODUCTION

Currently, kidney transplantation has become an effective therapy for end-stage renal failure, which not only prolongs the life of recipients but also improves their quality of life[1,2]. Accurate assessment of renal function is of great importance in the maintenance of adequate nephrons of renal recipients after kidney

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transplantation[3]. Glomerular filtration rate (GFR), as a sensitive marker for assessing renal function, can effectively evaluate the functions of living kidneys from family members before surgery. At present, there is still no uniform standard for donor GFR of living kidneys from family members, although in most protocols it is ≥ 40 ml/min. Thereby motivated, we aimed to explore the roles of donor GFR and donor/recipient body surface area (BSA) ratio in kidney selection for living transplantation from family members.

SUBJECTS AND METHODS

Baseline information

The patients with uremia who received living kidney transplantation from family members in our hospital from February 2011 to February 2015 were selected. This study has been approved by the ethics committee of our hospital, and written consent has been obtained from all patients.

Inclusion criteria: the following criteria were included in the study: (1) recipients and their donors who underwent renal transplantation for the first time, (2) recipients and their donors who were regularly followed up in the kidney transplantation outpatient clinic of our hospital after surgery, and (3) follow-up for more than 2 years. Exclusion criteria: the following criteria were excluded from the study: (1) recipients and their donors who had received renal transplantation before and (2) recipients and their donors with perioperative vascular complications.

Finally, a total of 204 cases who required kidney transplantation due to uremia were included in this study.

Pre-operative examinations

General pre-operative examinations of donors and recipients

General pre-operative examinations included biochemical tests and imaging studies. Imaging studies included color Doppler ultrasounds for the urinary tract, digestive system, and heart.

Pre-operative determination of donor GFR

The non-radionuclide marker iohexol (Euronec 350) filtered through the glomerulus without tubular secretion was used for GFR determination. The GFR values of both of the donor's kidneys were calculated according to the clearance rate and amount of radiopharmaceutical drug[4].

Pre-operative determination of BSA of donors and recipients

Mosteller method was used for the calculation of BSA: BSA (m^2) = ([height × weight]/3600)$^{1/2}$, height in cm and weight in kg[5].

Tissue typing

ABO blood typing, lymphotoxin test (crossmatch test), human leukocyte antigen test, and population reactive antibody test were performed[6].

Selection and transplantation of donor kidney

A suitable donor and kidney were chosen according to the GFR values of both kidneys[7]. After a small incision was made on the waist, the left kidney was taken in 118 cases and the right kidney in 86 cases. After being excised, the donor kidney was immediately placed in and lavaged with 0°C hypertonic citrate adenine solution. The average time of warm ischemia during surgery was 3.21 ± 1.54 min and that of cold ischemia was 28.41 ± 14.24 min.

Surgical procedure of recipients

After successful anesthesia, the recipient in the supine position underwent an L-shaped incision on the right lower abdomen. After internal and external iliac veins were completely free, all the bleeding points were ligated. The isolated kidney, lavaged and stored in 0°C hypertonic citrate adenine solution, was wrapped with ice and moved to the operating table. Then, 6-0 thread was used for the end-to-end anastomosis of renal artery and internal iliac artery. Subsequently, 5-0 thread was used for the end-to-side anastomosis of renal vein and external iliac vein[8].

Then, the surgical incision was closed outward layer by layer.

Post-operative treatment of recipients

The recipients were strictly isolated and monitored after routine renal transplantation. After surgery, particular attention was paid to their blood pressure, pulse, and central venous pressure.

Immunosuppression induction regimen

Before surgery, 80 mg of methylprednisolone (MP) and 50 mg of anti-thymocyte globulin (ATG) were intravenously instilled for immune induction. MP (1000 mg) was intravenously infused intraoperatively. After surgery, MP and ATG were used to prevent rejection: 500 mg MP and 50 mg ATG on day 1; 500 mg MP and 50 mg ATG on day 2; 375 mg MP and 50 mg ATG on day 3; 250 mg MP and 50 mg ATG on day 4; 120 mg MP and 50 mg ATG on day 5; and oral administration of 20 mg/day prednisone on day 6. The amount of post-operative oral prednisone was gradually decreased to 10 mg/day after 3 months and to 5 mg/day after 6 months.

Immunosuppression maintenance regimen

The recipients took oral immunosuppressive agents from the 1st day after surgery; 174 patients took tacrolimus + mycophenolate mofetil and 30 patients received cyclosporine + mycophenolate mofetil + prednisone.

Dose of tacrolimus

CYP3A enzyme has three genotypes, i.e., 1/*1-type, *1/*3-type, and *3/*3-type, which evidently affect the trough value of tacrolimus dose. The initial doses for 1/*1-type, *1/*3-type, and *3/*3-type recipients were 0.08 mg/kg/d, 0.07 mg/kg/d, and 0.05 mg/kg/d, respectively. The renal function was monitored daily postoperatively. When the serum creatinine (S_{Cr}) level of recipients was dropped to below 240 μmol/L, the corresponding dose was increased: the doses of tacrolimus for 1/*1-type, *1/*3-type, and *3/*3-type recipients were 0.15 mg/kg/d, 0.12-0.14 mg/kg/d, and 0.09-0.11 mg/kg/d, respectively.

Dose of cyclosporine

The initial dose of cyclosporine was 6-7 mg/kg/d. The cyclosporine concentration (C0) was checked 3 days later. The dose of cyclosporine was adjusted according to C0 and renal graft function. C0 was usually controlled at 250-300 μg/L 1 week after surgery, at 200-250 μg/L 1 month after surgery, at 150-200 μg/L 3 months after surgery, and at above 100 μg/L more than 6 months after surgery.

Post-operative sample collection and detection

All recipients took immunosuppressive drugs at 7:00 h and 19:00 h daily. Venous blood (5 ml) was collected in the morning, half an hour (6:30 h) before taking the drugs, of which 2 ml were aliquoted in an anticoagulant tube containing ethylenediaminetetraacetic acid (EDTA) for the detection of whole-blood immunosuppressor concentration by fluorescence polarization immunoassay. Then, 1 ml of sample in the EDTA K2 tube was used for routine blood test, and 2 ml in the separation gel/coagulant tube was employed to detect indices such as liver and kidney functions.

Detection of post-operative GFR of recipients

Estimated GFR (eGFR) was calculated by the CKD-EPI equation: eGFR (ml/min·[1.73 m^2]$^{-1}$) = 141 × [S_{Cr}/κ] × (0.993)age × (1.018 if female). S_{Cr} = serum creatinine. Unit for S_{Cr}: mg/dL[9]. κ: Female = 0.7, male = 0.9. Female: $S_{Cr} \leq 0.7$, a = −0.329; $S_{Cr} > 0.7$, a = −1.209. Male: $S_{Cr} \leq 0.9$, a = −0.411; $S_{Cr} > 0.9$, a = −1.209.

Statistical analysis

All data were analyzed by SPSS 19.0 and expressed as mean ± standard deviation (x ± s). The data of multiple groups with normal distribution and variance homogeneity were compared by one-way analysis of variance, and intergroup comparisons were conducted by the t-test of two independent samples. Data without normal distribution or variance homogeneity were compared by the non-parametric test. Comparisons among multiple groups were performed by the Kruskal-Wallis H (K) test, and those between two groups were carried out by the Mann–Whitney U-test. $p < 0.05$ was considered to be statistically significant.

Table 1. Baseline clinical data

Group	n	Age (years)	Gender	Primary disease (case)		Pre-operative serum creatinine	Pre-operative hemoglobin	PRA (positive/ negative)	HLA (positive/ negative)	MICA (positive/ negative)
			(M/F)	Chronic glomerulo-nephritis	Others	(mg/dL)	(g/L)			
A	13	28.3 ± 1.4	9/4	9	4	9.78 ± 0.25	92.38 ± 6.86	8/5	9/4	9/4
B	28	33.5 ± 1.3	23/5	20	8	10.19 ± 0.24	91.75 ± 7.52	22/6	23/5	23/5
C	8	31.3 ± 1.5	7/1	6	2	10.11 ± 0.26	92.51 ± 7.41	6/2	7/1	6/2
D	33	29.6 ± 1.1	25/8	25	8	10.10 ± 0.28	92.65 ± 6.53	24/9	24/9	25/8
E	98	34.4 ± 1.3	75/23	68	30	10.15 ± 0.27	91.63 ± 6.84	74/24	74/24	75/23
F	24	28.7 ± 1.6	16/8	18	6	10.33 ± 0.32	92.51 ± 7.01	16/8	16/8	16/8
P		0.156	0.875	0.693	0.431	0.832	0.791	0.704	0.903	

RPA: panel reactive antibody; HAL: human leukocyte antigen; MICA: major histocompatibility complex class I-related chain A.

Table 2. Clinical data of donors

Donor (n = 204)	Age (age)	Gender (male/female)	Hypertension	Diabetes	Pre-operative serum creatinine (mg/dL)	Post-operative eGFR (ml/min)
	45.71 ± 9.81	150/54	0	0	0.68 ± 0.12	94.82 ± 48.28

eGFR: estimated glomerular filtration rate.

RESULTS

Baseline clinical data

A total of 204 cases were retrospectively analyzed. There were six groups (A-F) according to the donor GFR and donor/recipient BSA ratio: GFR < 40 ml/min and donor/recipient BSA ratio ≤ 0.8 in Group A; GFR < 40 ml/min and 0.8 < donor/recipient BSA ratio ≤ 1.2 in Group B; GFR < 40 ml/min and donor/recipient BSA ratio > 1.2 in Group C; GFR ≥ 40 ml/min and donor/recipient BSA ratio ≤ 0.8 in Group D; GFR ≥ 40 ml/min and 0.8 < donor/recipient BSA ratio ≤ 1.2 in Group E; and GFR ≥ 40 ml/min and donor/recipient BSA ratio > 1.2 in Group F.

The six groups had similar baseline clinical data before surgery ($p > 0.05$) (Table 1). During follow-up, 3 cases in Group A and 2 cases in Group B were suffered from mesangial proliferative glomerulonephritis that was confirmed by biopsy 2 months after surgery. Their creatinine levels slowly increased, and they began to receive hemodialysis again 25 months after transplantation. The other kidney functions were well maintained.

Three cases in Group E and 5 cases in Group F suffered from urine reduction, transplanted kidney swelling, and pain which were diagnosed as acute rejection response. After pulse dose therapy with MP, all the symptoms disappeared. The six groups did not present chronic rejection response during follow-up.

Clinical data of donors are listed in table 2. Donors were followed up for 2 years, without severe complications. They are all alive to this day.

Table 3. Post-operative serum creatinine levels and eGFR values of recipients with different GFR values at different time points after surgery

Physical and chemical indicators	Group	n	1 week	1 month	3 months	6 months	12 months	24 months
Post-operative serum creatinine (mg/dl)	GFR < 40	50	1.45 ± 0.11	1.49 ± 0.09	1.40 ± 0.12	1.30 ± 0.08	1.43 ± 0.08	1.45 ± 0.09
	GFR ≥ 40	154	1.43 ± 0.10	1.46 ± 0.10	1.39 ± 0.12	1.29 ± 0.11	1.42 ± 0.08	1.44 ± 0.09
	p		0.232	0.061	0.560	0.554	0.443	0.496
Postoperative eGFR (ml/min)	GFR < 40	50	64.11 ± 5.6	61.15 ± 4.2	65.11 ± 5.1	69.71 ± 4.8	69.11 ± 4.3	70.31 ± 4.8
	GFR ≥ 40	154	65.17 ± 4.1	62.15 ± 4.0	65.12 ± 5.3	70.12 ± 4.9	71.14 ± 4.4	71.19 ± 4.9
	p		0.175	0.343	0.854	0.475	0.362	0.432

eGFR: estimated glomerular filtration rate, GFR: glomerular filtration rate.

Post-operative evaluation when considering GFR alone

The post-operative S_{Cr} reduction rate, steady-state S_{Cr} level, and eGFR of the donor GFR ≥ 40 ml/min group were slightly higher than those of the donor GFR < 40 ml/min group ($p > 0.05$) (Table 3).

Post-operative evaluation when considering donor/recipient BSA ratio alone

The renal function recovery of the donor/recipient BSA ratio ≤ 0.8 group (Group A) after surgery was significantly worse than that of the donor/recipient BSA ratio ≥ 1.2 group (Group C) ($p < 0.05$) (Tables 4 and 5). Group B comprised recipients with 0.8 < donor/recipient BSA ratio < 1.2.

Post-operative evaluation when simultaneously considering GFR and donor/recipient BSA ratio

The post-operative S_{Cr} reduction rate, steady-state S_{Cr} level, and graft kidney eGFR of Group A were all significantly lower than those of the other five groups ($p < 0.05$). Such values of Groups C and F were significantly higher than those of the other four groups ($p < 0.05$) (Fig. 1, Tables 6 and 7).

Univariate and multivariate analyses of donor GFR and donor/recipient BSA ratio

Both univariate and multivariate analyses showed that donor GFR and donor/recipient BSA ratio were positively correlated with the post-operative kidney functions of recipients ($p < 0.001$) (Table 8).

DISCUSSION

Kidney shortage is a bottleneck that has limited the development of transplantation in recent years[10], which can be solved by transplanting living kidney

Figure 1. Percentage of recipients with normal serum creatinine levels 1 week after surgery

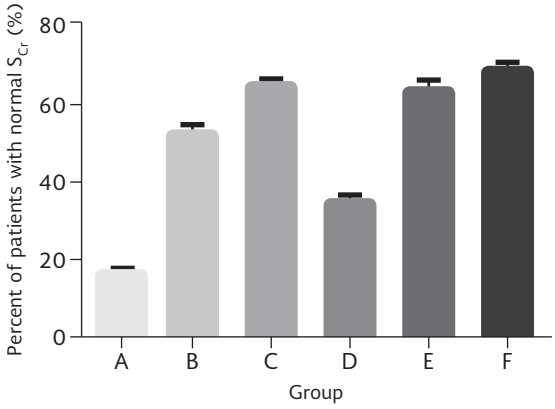

Table 4. Post-operative serum creatinine levels of recipients with different donor/recipient BSA ratios at different time points after surgery (mg/dL)

Groups	n	1 week	1 month	3 months	6 months	12 months	24 months
A	46	1.50 ± 0.11	1.60 ± 0.10	1.48 ± 0.11	1.45 ± 0.08	1.44 ± 0.09	1.35 ± 0.07
B	126	1.33 ± 0.10a	1.46 ± 0.10	1.41 ± 0.10	1.33 ± 0.09	1.32 ± 0.10	1.34 ± 0.08
C	32	1.20 ± 0.12a	1.20 ± 0.10a	1.15 ± 0.11a	1.03 ± 0.08a	1.01 ± 0.10ab	1.08 ± 0.08ab
p		0.003	0.002	0.000	0.000	0.000	0 000

[a]Comparison to recipients with donor/recipient BSA ratio ≤ 0.8, $p < 0.05$; [b]Comparison to recipients with 0.8 < donor/recipient BSA ratio ≤ 1.2, $p < 0.05$.
BSA: body surface area

Table 5. Post-operative eGFR values of recipients with different donor/recipient BSA ratios at different time points after surgery (ml/min)

Group	n	1 week	1 month	3 months	6 months	12 months	24 months
A	46	60.51 ± 9.52	56.14 ± 8.15	64.15 ± 9.15	61.51 ± 7.15	63.14 ± 8.11	65.44 ± 6.15
B	126	78.01 ± 95.1a	75.11 ± 8.16	74.16 ± 9.11	69.15 ± 7.16	69.15 ± 8.17	78.14 ± 6.19
C	32	86.18 ± 10.13a	79.91 ± 8.19a	75.15 ± 9.14a	79.93 ± 7.13a	85.27 ± 9.11ab	80.13 ± 7.13ab
p		0.024	0.125	0.215	0.041	0.003	0 152

[a]Comparison to recipients with donor/recipient BSA ratio ≤ 0.8, $p < 0.05$; [b] comparison to recipients with 0.8 < donor/recipient BSA ratio ≤ 1.2, $p < 0.05$.
eGFR: estimated glomerular filtration rate, BSA: body surface area

Table 6. Serum creatinine levels at different time points after surgery (mg/dL)

Group	n	1 week	1 month	3 months	6 months	12 months	24 months
A	13	1.70 ± 0.08	1.82 ± 0.09	1.72 ± 0.09	1.66 ± 0.08	1.51 ± 0.08	1.61 ± 0.07
B	28	1.47 ± 0.08	1.47 ± 0.10	1.35 ± 0.10	1.28 ± 0.08	1.36 ± 0.08	1.32 ± 0.07
C	8	1.16 ± 0.07	1.12 ± 0.07	1.04 ± 0.06	1.02 ± 0.06	1.04 ± 0.06	1.03 ± 0.05
D	33	1.54 ± 0.07	1.55 ± 0.08	1.39 ± 0.09	1.39 ± 0.09	1.42 ± 0.07	1.28 ± 0.07
E	98	1.29 ± 0.08	1.45 ± 0.09	1.40 ± 0.08	1.34 ± 0.09	1.29 ± 0.07	1.35 ± 0.07
F	24	1.21 ± 0.09	1.22 ± 0.07	1.17 ± 0.08	1.02 ± 0.10	1.01 ± 0.05	1.11 ± 0.05
P		0.019	0.092	0.003	0.019	0.007	0 215

Table 7. eGFR values at different time points after surgery (ml/min)

Group	n	1 week	1 month	3 months	6 months	12 months	24 months
A	13	51.13 ± 3.12	48.17 ± 2.18	46.91 ± 2.15	48.15 ± 2.17	50.61 ± 2.18	50.21 ± 2.17
B	28	62.14 ± 2.19	60.15 ± 2.51	66.41 ± 2.13	67.14 ± 2.15	65.18 ± 2.18	70.15 ± 2.16
C	8	87.13 ± 3.12	82.15 ± 2.51	84.21 ± 2.81	80.14 ± 2.17	81.51 ± 2.12	83.51 ± 2.14
D	33	61.12 ± 3.15	59.16 ± 3.41	66.71 ± 2.81	63.14 ± 2.18	62.8 ± 2.18	67.51 ± 6.11
E	98	77.11 ± 3.18	67.13 ± 2.19	63.18 ± 2.18	71.15 ± 2.17	72.2 ± 3.11	70.15 ± 2.18
F	24	83.91 ± 2.18	79.12 ± 2.19	71.15 ± 3.11	82.15 ± 2.18	86.3 ± 3.14	80.15 ± 3.14
p		0.023	0.089	0.002	0.024	0.006	0.187

eGFR: estimated glomerular filtration rate

Table 8. Univariate and multivariate analyses of donor GFR and donor/recipient BSA ratio

Index	Univariate			Multivariate	
	Correlation coefficient	95% CI	*p*	Correlation coefficient	*p*
Donor GFR	0.27	0.17-0.37	<0.001	0.26	<0.001
Donor/recipient BSA ratio	35.74	20.75-50.72	<0.001	41.17	<0.001

GFR: glomerular filtration rate, BSA: body surface area, CI: confidence interval.

from family members[11]. The prognosis is related to the quality of life of both recipient and donor. Therefore, donors should be subjected to complete, detailed, and strict general physical examinations before kidney transplantation to select the best family member[12,13].

GFR is currently a sensitive biochemical index for kidney function, but there is no uniform standard for the choice of living kidney transplantation from family members. Most transplant centers require GFR of both of the donor's kidneys to exceed 40 ml/min. Thus, there is still a controversy over the selection of donor kidneys with GFR lower than 40 ml/min.

BSA influences the incidence of delayed graft function and acute rejection and the recovery of renal graft function after transplantation[14-16]. Therefore, we should also consider the ratio of donor/recipient BSA in the living renal transplantation from family members. In our hospital, the recovery of recipient renal graft function with the donor GFR < 40 ml/min after living renal transplantation from family members was slightly worse than that of recipients with donor GFR ≥ 40 ml/min. Hence, we strictly controlled the inclusion criteria of donors with GFR < 40 ml/min before surgery and took into account the donor/recipient BSA ratio, so the living donor kidney transplantations with GFR < 40 ml/min and GFR 40 ml/min had similar effects. After surgery, the S_{Cr} level of the group with donor GFR < 40 ml/min was slightly higher than that of the group with donor GFR ≥ 40 ml/min at each time point. Meanwhile, eGFR of the group with donor GFR < 40 ml/min was slightly lower than that of the group with donor GFR ≥ 40 ml/min at each time point. Therefore, although GFR of donor may affect the post-operative renal function of recipients, the effect may be minimized by controlling surgical indications and reasonably selecting GFR < 40 ml/min recipients. After surgery, the group with donor/recipient BSA ratio ≤ 0.8, the group with donor/recipient BSA ratio > 0.8 to ≤ 1.2, and the group with donor/recipient BSA ratio > 1.2 had similar incidence rates of delayed graft function and acute rejection.

The S_{Cr} level of the group with donor/recipient BSA ratio ≤ 0.8 at each time point was slightly higher than those of the group with donor/recipient BSA ratio > 0.8 to ≤ 1.2 and the group with donor/recipient BSA ratio > 1.2. Meanwhile, the group with donor/recipient BSA ratio ≤ 0.8 had a slightly lower eGFR at each time point than those of the group with donor/recipient BSA ratio > 0.8 to ≤ 1.2 and the group with donor/recipient BSA ratio > 1.2. Thus, the ratio of donor/recipient BSA may affect recipient renal function after transplantation to a certain extent. The S_{Cr} levels of the six groups of recipients decreased rapidly in the 1st week after kidney transplantation. The ratio of the recipients' group with donor GFR < 40 ml/min and donor/recipient BSA ≤ 0.8 to normal ratio was significantly lower than those of the other five groups, suggesting that the two indices significantly affected the recovery of transplanted kidney in recipients at the early stage and the early compensatory capacity of recipients was also low. The S_{Cr} levels of the six groups of recipients decreased slowly and gradually stabilized 1 week after renal transplantation, with significant differences in the stable period. The S_{Cr} level of the group with donor GFR < 40 ml/min and donor/recipient BSA ≤ 0.8 at each time point was significantly higher than those of the other five groups. The S_{Cr} levels of the group with donor GFR < 40 ml/min and donor/recipient BSA ratio > 1.2 and the group with donor GFR ≥ 40 ml/min and donor/recipient BSA ratio > 1.2 were all significantly lower than those of the other four groups. The group with donor GFR < 40 ml/min and donor/recipient BSA ratio ≤ 0.8 had a significantly lower eGFR than those of the

other five groups at each time point. Besides, the eGFR values of the group with donor GFR < 40 ml/min and donor/recipients BSA ratio > 1.2 and the group with donor GFR ≥ 40 ml/min and donor/recipient BSA ratio > 1.2 at each time point were significantly higher than those of the other four groups. Accordingly, donor GFR < 40 ml/min and donor/recipient BSA ratio ≤ 0.8 obviously affected the mid- and long-term renal function recoveries of recipients, with unsatisfactory outcomes. The recipients with donor/recipient BSA ratio > 1.2 recovered more rapidly, and the S_{Cr} level also decreased quickly to normal. In particular, the effects of donor GFR ≥ 40 ml/min and donor/recipient BSA ratio > 1.2 were significantly different. The donors were followed up for 2 years, without severe complications. They are all alive up to this day.

In conclusion, the postoperative renal graft recovery was affected by both donor GFR and BSA of recipients. Especially, when the donor/recipient BSA ratio was ≤ 0.8, the renal graft function of recipients with donor GFR < 40 ml/min hardly recovered to normal. Therefore, the donor kidneys with donor/recipient BSA ratio < 0.8 and GFR < 40 ml/min should be avoided. When donor/recipient BSA ratio was > 0.8 or ≤ 1.2, there was no significant difference in S_{Cr} level or eGFR at each time point after surgery between the group with donor GFR < 40 ml/min and the group with donor GFR ≥ 40 ml/min. When donor/recipient BSA ratio was > 1.2, these two groups had similar S_{Cr} levels and eGFR values at each time point after surgery, and the group with donor GFR < 40 ml/min had better renal graft function at each time point than those of the group with donor/recipient BSA ratio ≤ 1.2 and donor GFR ≥ 40 ml/min. When donor/recipient BSA ratio was > 0.8, the effect of donor GFR on the recovery of renal graft function after surgery was attenuated, and there was no significant difference in the recovery of renal graft function between the recipients with donor GFR < 40 ml/min and GFR ≥ 40 ml/min.

Thus, the ratio of donor/recipient BSA should be considered besides donor GFR in the selection of living renal transplantation from family members. For donors with donor/recipient BSA ratio ≥ 0.8, especially those with the ratio ≥ 1.2, GFR below 40 ml/min may also be applicable. Nevertheless, this study did not have data of time-zero biopsies in grafts of living donors. Further, in-depth studies are ongoing in our group.

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