

Postoperative Compensatory Changes and Blood Flow Parameter of the Preserved Kidney in Elderly Living Related Donors Evaluated by Doppler Ultrasonography

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ABSTRACT

Introduction. Elderly kidney donors have recently become more common in living related kidney transplantation in Japan. Therefore, it is important to evaluate whether kidney function in elderly donors after nephrectomy is preserved over long periods of time. Doppler ultrasonography measurement is practical for donors after nephrectomy because it involves simple and noninvasive examinations. Doppler ultrasonography can detect compensatory hypertrophy and blood flow parameters, namely resistive index (RI) and pulsatility index (PI), of the preserved kidney in living donors.

Patients and Methods. Our study included 58 donors, divided into 2 groups according to age; the elderly donor group was comprised of those 65 years old or older. We measured length, width, and short diameter of the preserved kidney using Doppler ultrasonography, and calculated kidney volume.

Results. The elderly group was comprised of 13 patients. In this group, the median preserved kidney volume was 145.0 cm³ (101.8–193.5) before nephrectomy, and 127.6 cm³ (99.0–183.4) and 145.5 cm³ (141.3–148.6) at 1 and 12 months after nephrectomy, respectively. We did not observe significant compensatory hypertrophy in the preserved kidneys of elderly donors postoperatively. Both the mean PI and RI values of elderly donors increased progressively after nephrectomy. No compensatory hypertrophy occurred in the preserved kidneys of elderly donors, although the PI and RI did increase in these donors.

Conclusion. Our results indicate that nephrectomy caused nephrosclerosis in the preserved kidneys of elderly donors and that prevention of hypertension may be important after nephrectomy in elderly donors.

ELDERLY kidney donors, previously regarded as marginal donors, have recently become more common in living related kidney transplantation owing to the current shortage of organs worldwide, including in Japan. Therefore, it is important to evaluate whether kidney function after nephrectomy is preserved over long periods of time in elderly donors [1]. We have checked renal function in all living related donors at an outpatient clinic 1 or more times after nephrectomy. Doppler ultrasonography as well as serum creatinine measurement is practical for donors after nephrectomy because these are simple and noninvasive examinations that can be conducted easily in an outpatient clinic. Doppler ultrasonography can measure size and blood flow parameters (resistive index [RI] and pulsatility index

[PI]) of the preserved kidney in living donors without physical invasion. Our observation indicated that blood flow parameters in elderly donors were higher than in nonelderly donors and that compensatory hypertrophy was not evident. Those consequences show that compensatory hypertrophy does not occur with a compliance-reduced intrarenal artery. We suggest that blood pressure control is effective for

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elderly donors to maintain postoperative preserved kidney function.

PATIENTS AND METHODS

Objectives

We aimed to evaluate preserved kidney function in elderly donors by comparing preoperative and postoperative parameters, as well as by comparing elderly donors to their nonelderly counterparts. Our study included 58 donors, divided into 2 groups according to age; the elderly donor group was comprised of those 65 years old or older. There were 13 elderly donors and 45 nonelderly donors. Detailed donor characteristics shown in [Table 1](#).

Donor Criteria and Nephrectomy

Renal function for living donors requires 24-hour creatinine clearance of 80 mL/min/1.73 m² or above. Donor nephrectomy was performed using transabdominal hand-assisted laparoscopic surgery in all 58 cases. If there was no difference in renal function between right and left, we excised the left-side kidney in principle; left-side kidney was removed in all cases.

Measurement of Preserved Kidney Function, Size, and Volume

All donors were followed up for at least 1 year at our hospital and were checked by measuring serum creatinine level at an outpatient clinic preoperatively and at 1 and 12 months after nephrectomy. At the same time, we measured length, width, and short diameter of the preserved kidney using Doppler ultrasonography, and calculated kidney volume using the ellipsoid calculation, as $V \text{ (cm}^3\text{)} = 4/3\pi \times \text{length}/2 \times \text{width}/2 \times \text{short diameter}/2$. We also measured PI and RI of the renal, segmental, and interlobar arteries in the preserved kidneys simultaneously by Doppler ultrasonography. Doppler ultrasonography was performed by the clinical laboratory technician in our hospital.

Statistics

Preoperative characteristics of the elderly group and the nonelderly group were shown by mean values \pm standard deviation; between-group comparisons were performed using the Student *t* test. Comparisons of measurement values over the course of the study period were analyzed using Friedman's χ^2 test. Preoperative and postoperative data measured by Doppler ultrasonography were expressed as median \pm interquartile range (IQR). We analyzed whether obtained data had a normal distribution using the Shapiro-Wilk test. The significance level was set at $P < .05$. The data were analyzed using SPSS Statistics Ver. 22 (IBM Corp., Armonk, N.Y., United States).

Table 1. Donor Characteristics

	Elderly Donors	Non-Elderly Donors	P Value
Number	13	45	
Sex (M/F)	3/10	18/27	.61
Age	66-73	26-64	.00
Serum Cr (mg/dL)	0.66 \pm 0.12	0.66 \pm 0.13	.91
eGFR (mL/min/1.73 m ²)	76.9 \pm 15.2	88.5 \pm 16.9	.03

Abbreviations: Cr, Creatinine; eGFR, estimated glomerular filtration rate.

RESULTS

The elderly group was comprised of 13 patients between 66 and 73 years old. In this group, the mean serum creatinine value was 0.65 \pm 0.12 mg/dL, and the estimated glomerular filtration rate (eGFR) value was 76.9 \pm 15.8 mL/min/1.73 m². The nonelderly group was comprised of 45 patients between 26 and 64 years old. In this group, the mean serum creatinine value was 0.66 \pm 0.13 mg/dL, and eGFR value was 88.5 \pm 16.9 mL/min/1.73 m². There were significant differences in donor age and eGFR value between groups. Detailed donor characteristics are shown in [Table 1](#).

In the elderly group, the median right-side kidney volume was 145.0 cm³ (101.8-193.5) preoperatively, and the preserved kidney volume was 127.6 cm³ (99.0-183.4) and 145.5 cm³ (141.3-148.6) at 1 and 12 months after nephrectomy, respectively. In the nonelderly donor group, the median right-side kidney volume was 121.8 cm³ (101.0-145.5) preoperatively, and the preserved kidney volume was 157.7 cm³ (129.6-157.7) and 149.4 cm³ (146.2-154.9) at 1 and 12 months after nephrectomy, respectively. We did not observe significant compensatory hypertrophy in the preserved kidneys of the elderly donors postoperatively.

The median PI of the elderly group was 1.07 (0.92-1.10) preoperatively and 1.07 (1.05-1.19) and 1.05 (0.91-1.21) at 1 and 12 months after nephrectomy, respectively. The median RI was 0.63 (0.57-0.64) preoperatively, and 0.63 (0.61-0.65) and 0.62 (0.57-0.66) at 1 and 12 months after nephrectomy, respectively. The median PI of the nonelderly group was 0.99 (0.84-1.06) preoperatively and 0.99 (0.96-1.06) and 0.97 (0.91-0.97) at 1 and 12 months after nephrectomy, respectively. The median RI was 0.61 (0.54-0.62) preoperatively and 0.59 (0.58-0.60) and 0.60 (0.57-0.60) at 1 and 12 months after nephrectomy, respectively ([Table 2](#)). There were statistically significant differences in the PI and RI values between elderly and nonelderly donor groups at each measurement time. In elderly donors, we could not confirm compensatory hypertrophy up to 12 months after nephrectomy or significant

Table 2. Blood-flow Parameters and Preserved Kidney Volume Measured by Doppler Ultrasonography

	Elderly donors median (IQR)	Non-elderly donor median (IQR)	P Value
Pre-operation			
RV (cm ³)	145.0 (101.8-193.5)	121.8 (101.0-145.6)	.510
PI	1.07 (0.92-1.10)	0.99 (0.84-1.06)	.000
RI	0.63 (0.57-0.64)	0.61 (0.54-0.62)	.007
Post-operative 1 month			
RV (cm ³)	127.6 (99.0-183.4)	157.7 (129.6-157.7)	.040
PI	1.07 (1.06-1.19)	0.99 (0.96-1.06)	.001
RI	0.63 (0.61-0.65)	0.59 (0.58-0.60)	.001
Post-operative 12 month			
RV (cm ³)	145.5 (141.3-148.6)	149.4 (146.2-154.9)	.239
PI	1.06 (0.91-1.22)	0.97 (0.91-0.97)	.000
RI	0.62 (0.57-0.66)	0.60 (0.57-0.60)	.001

Abbreviations: IQR, Interquartile range; Cr, creatinine; RV, renal volume; PI, Pulsatility Index; RI, Resistive Index.

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