



# Role of Computed Tomography Volumetry in Preoperative Donor Renal Function Evaluation of Living Related Kidney Transplantation

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## ABSTRACT

**Introduction.** Renal scintigraphy is used to evaluate split renal function. A computed tomography (CT) examination is also carried out for donor safety and appropriate transplantation surgery, and the renal volume (CT volumetry) can be obtained at that time. In this study, we evaluated donor kidney function by inulin clearance (Cin) before and after donor nephrectomy in living donor renal transplantation, and the predictive role of CT volumetry was compared with diethylenetriamine pentaacetic acid (DTPA).

**Method.** From November 2005 to April 2018, 34 cases of living donor transplantation conducted at Fukuoka University Hospital were retrospectively studied. The donated kidney weight was measured in 25 cases, and postoperative Cin was measured in 19 cases.

**Results.** The average donor age was 51.7 years old (from 35 to 71). Preoperative Cin and postoperative Cin of donors were 86.3 mL/min/1.73 m<sup>2</sup> (from 59.5 to 138.3) and 52.3 (from 40.5 to 76.6), respectively. The average CT volumetry of donated kidneys was 153.9 mL (from 107.8 to 219.3). Correlations of weight and DTPA and CT volumetry of donated kidneys were  $r = 0.033$  ( $P = .8770$ ) and  $r = 0.763$  ( $P < .0001$ ), respectively. Correlations of glomerular filtration rate of DTPA and CT volumetry and Cin of postoperative donor residual kidneys were  $r = 0.66$  ( $P = .002$ ) and  $r = 0.555$  ( $P = .014$ ).

**Conclusion.** There was a significant correlation between CT volumetry and the weight of the removed kidneys, and a correlation between Cin after donor nephrectomy and CT volumetry of the remaining kidneys, but it did not exceed the predictive role of DTPA. However, it was suggested that it is worthy to use as a preoperative examination for split renal function equivalent to DTPA.

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**I**N THE PREOPERATIVE examination of the renal donors for living donor renal transplantation, renal function evaluation is performed from the standpoint of donor adaptation and postoperative donor protection. In many transplant hospitals, renal scintigraphy is used to evaluate split renal function. Renal scintigraphy has various limitations such as easy image artifacts, exposure to radioactive isotopes, and time required for examination. Prior to surgery, a computed tomography (CT) examination is carried out for donor safety and appropriate transplantation surgery, and the renal volume (CT volumetry) can be obtained at that time. It is reported that CT volumetry of the kidney is useful. In this study, we evaluated donor kidney function by inulin clearance (Cin) before and after donor nephrectomy in living donor renal

transplantation, and the predictive role of CT volumetry was compared with diethylenetriamine pentaacetic acid (DTPA).

## MATERIALS AND METHODS

From November 2005 to April 2018, 34 cases (12 men and 22 women) of living donor transplantation conducted at Fukuoka University Hospital were retrospectively studied. The donated kidney weight was measured in 25 cases, and postoperative Cin was

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**Table 1. Characteristics of Live Kidney Donor: Renal Function of Donor Decreased by Mean 39.4% of Cin by Donor Nephrectomy**

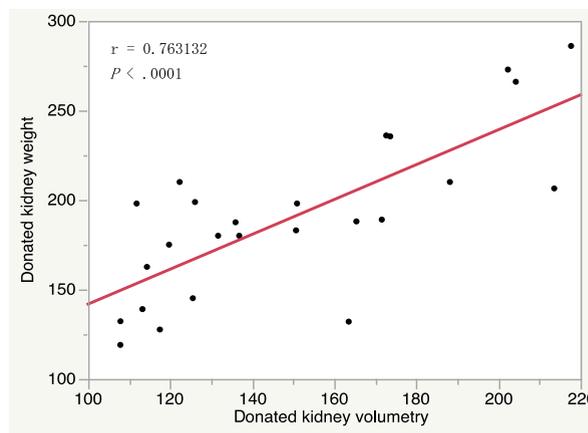
Age at operation (mean and ranges)	51.7 (35–71) years old
Sex: male/female	12/22 cases
Kidney donated: left/right	27/7 cases
SCr preop/postop (mean and ranges), n = 34	0.73 (0.4–1.1)/1.16 (0.7–1.7) mg/dL
eGFR preop/postop (mean and ranges), n = 34	75.2 (55.3–101.7)/46.0 (28.0–70.1) mL/min/1.73 m <sup>2</sup>
Cin preop/postop (mean and ranges), n = 19	86.3 (59.5–138.3)/52.3 (40.5–76.6) mL/min/1.73 m <sup>2</sup>
DTPA (GFR) donated side/remaining side (mean and ranges), n = 34	42.3 (24.0–66.0)/43.4 (26–78) mL/min/1.73 m <sup>2</sup>
CT volumetry donated side/remaining side (mean and ranges), n = 34	153.9 (107.8–219.3)/149.8 (99.4–261) mL

Abbreviations: Cin, inulin clearance; CT, computed tomography; DTPA, diethylenetriamine pentaacetic acid; eGFR, estimated glomerular filtration rate; GFR, glomerular filtration rate; SCr, serum creatinine.

measured in 19 cases. Renal function evaluation was based on serum creatinine (SCr), estimated glomerular filtration rate (eGFR) of the Japan Kidney Disease Association, Cin, and glomerular filtration rate (GFR) by <sup>99m</sup>Tc-DTPA, and CT volumetry was measured by enhanced CT and Ziostation2 ver.2 (Ziosoft Inc, Belmont, Calif, United States). Analyses were performed using JMP 12.2.0 (SAS Institute Inc, Cary, NC, United States). Significance was set at  $P < .05$ .

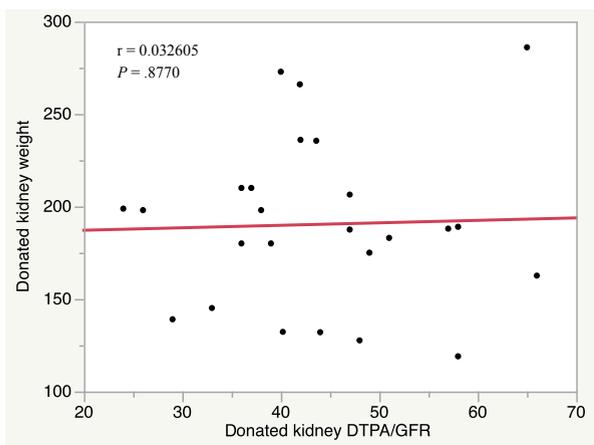
**RESULTS**

The average donor age was 51.7 years old (from 35 to 71). Preoperative Cin and postoperative Cin of donors were 86.3 mL/min/1.73 m<sup>2</sup> (from 59.5 to 138.3) and 52.3 (from 40.5 to 76.6), respectively. Renal function of donors decreased by a mean 39.4% of Cin by donor nephrectomy. The average CT volumetry of donated kidneys was 153.9 mL (from 107.8 to 219.3) (Table 1). Pearson’s correlation coefficient (r) and the corresponding P values for CT volumetry and DTPA of

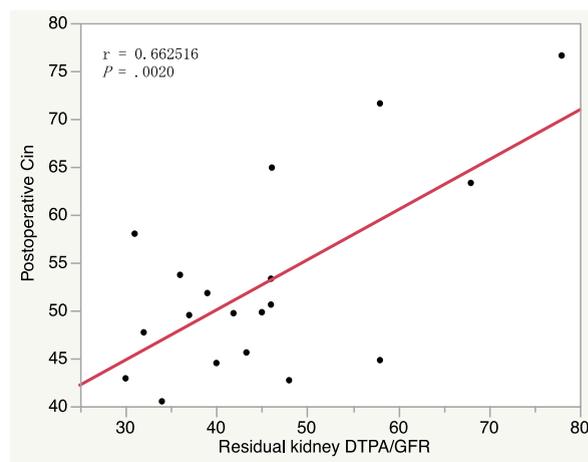


**Fig 2.** Correlation for donated kidney CT volumetry and kidney weight (n = 25).

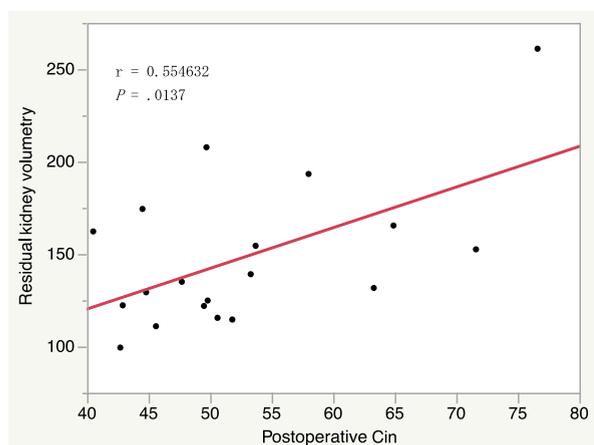
preoperative bilateral kidneys were  $r = 0.19$  ( $P = .2910$ ). There was no significant correlation between CT volumetry and GFR by DTPA. Correlations of GFR by DTPA and SCr, eGFR, and Cin of preoperative bilateral kidneys (n = 34) were  $r = 0.52$  ( $P = .0016$ ),  $r = 0.67$  ( $P < .0001$ ), and  $r = 0.44$  ( $P = .0309$ ), respectively. There was significant correlation between GFR by DTPA and Cr, eGFR, and Cin. Correlations of CT volumetries and SCr, eGFR, and Cin of preoperative bilateral kidneys (n = 34) were  $r = 0.25$  ( $P = .1554$ ),  $r = 0.14$  ( $P = .4445$ ), and  $r = 0.51$  ( $P = .0104$ ), respectively. There was significant correlation between CT volumetry and Cin. Correlation for donated kidney GFR by DTPA and kidney weight (n = 25) was  $r = 0.033$  ( $P = .8770$ ) (Fig 1). There was no significant correlation. Correlation for donated kidney CT volumetry and kidney weight (n = 25) was  $r = 0.763$  ( $P < .0001$ ) (Fig 2). There was significant correlation. Correlations of GFR of DTPA and CT volumetry and Cin of postoperative donor residual kidneys were



**Fig 1.** Correlation for donated kidney GFR by DTPA and kidney weight (n = 25).



**Fig 3.** Correlation for remaining kidney GFR by DTPA and postoperative Cin.



**Fig 4.** Correlation for remaining kidney CT volumetry and postoperative Cin.

$r = 0.66$  ( $P = .002$ ) (Fig 3) and  $r = 0.555$  ( $P = .014$ ) (Fig 4). There were significant correlations.

#### DISCUSSION

Evaluation of renal function of preoperative donors is important for donor protection in kidney transplantation. As for total renal function, the Japanese Society of Transplantation recommends Cin measurement, 80 mL/min/1.73 m<sup>2</sup> or more (marginal donor is 70 or more). In a donor's split renal function test, the guideline of Kidney Disease: Improving Global Outcomes (KDIGO) [1] established as an international organization recommends to use of DTPA and others, and traditionally DTPA has been performed [2]. There are reports that evaluation by CT volumetry by contrast CT is superior to DTPA [3-7]. In this study, the evaluation of renal function by CT volumetry showed the same significance as DTPA, but it did not exceed DTPA. By adding the qualitative assessment of the kidney with reference to renal biopsy at the time of donor nephrectomy, the value of kidney CT volumetry may increase. At present, it seems to be useful in evaluating a donor's kidney function in a multilateral way by CT volumetry data in addition to

DTPA. Since this study is a single-institutional study with a limited number of cases, further analysis such as accumulation of further cases and assessment is necessary.

#### CONCLUSION

The donor's renal function decreased by 39.4% of Cin after donor nephrectomy for living related kidney transplantation. There was no significant correlation between CT volumetry and DTPA of preoperative bilateral kidneys. There was a significant correlation between CT volumetry and the kidney weight of the donated kidneys and a correlation between Cin after donor nephrectomy and CT volumetry of the remaining kidney, but it did not exceed the predictive role of DTPA. However, it was suggested that it is worth using as a preoperative examination for split renal function equivalent to DTPA.

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