



# Long-term Follow-up of Living Kidney Donors With Chronic Kidney Disease at 1 Year After Nephrectomy

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## ABSTRACT

**Background.** Although renal function recovery of living kidney donors has been reported in a number of studies, many patients show poor recovery, and the long-term prognosis of these patients has not been well studied. In this investigation we explored the long-term prognosis of renal function in patients with chronic kidney disease (CKD) at 1 year after nephrectomy.

**Methods.** Patients who underwent donor nephrectomy during the period from March 2006 to April 2014, with a follow-up creatinine study at 1 year postoperatively and more than 3 years of follow-up, were included in the study. Creatinine and estimated glomerular filtration rate (eGFR, using the Modification of Diet in Renal Disease formula) before and after surgery were studied. Age, sex, history of hypertension or diabetes, body mass index, blood pressure, complete blood count, preoperative routine serum chemistry, and urine study results were reviewed.

**Results.** Among 841 patients who had donor nephrectomy, 362 were included in the study. There were 111 patients (30.6%) with eGFR  $<60$  mL/min/1.73 m<sup>2</sup> at 1 year post-surgery, and the median follow-up period was 62.8 months (interquartile range [IQR] 42.0–86.3 months). The maximum eGFR after 3-year follow-up was studied, and 48 patients (43.2%) never recovered eGFR to  $>60$  mL/min/1.73 m<sup>2</sup>. Age, history of hypertension, preoperative eGFR, and eGFR at 1 year were predictive factors at univariate analysis. Multivariate analysis of these factors was studied, and age (52.5 [IQR 47–55.7] vs 47 [IQR 7–53] years, odds ratio [OR] 1.1, 95% confidence interval [CI] 1.02–1.15,  $P = .007$ ), history of hypertension (16.7% vs 1.6%, OR 10.0, 95% CI 1.09–92.49,  $P = .042$ ), and eGFR at 1 year (53.9 [IQR 50.3–56.0] vs 57.0 [IQR 54.2–58.4] mL/min/1.73 m<sup>2</sup>, OR 0.8, 95% CI 0.72–0.92,  $P = .002$ ) remained as significant risk factors.

**Conclusion.** Of all living donors, 15.7% had CKD after  $>3$  years of follow-up. Close observation is warranted when donors have CKD after 1 year follow-up, as 43.2% fail to recover renal function. Patients who are older, have a history of hypertension, and have low eGFR at 1-year follow-up are especially at risk.

**L**IVING kidney donation is currently practiced worldwide and multiple guidelines provide medical and ethical direction for protection of living organ donors. One of the main goals of the medical guidelines is to ensure that the donor will have sufficient renal function after donation

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to continue on with a long, healthy life. To ensure preservation of renal function after donation, the pre-donation renal function of all potential donors is rigorously evaluated, and those with conditions such as kidney disease, diabetes, hypertension, and end-organ damage are excluded, as these conditions are anticipated to deteriorate renal function in the future [1]. The post-donation glomerular filtration rate (GFR) has been reported to reach 65% to 70% of the pre-donation GFR in healthy donors, and factors reported to be associated with risk of decreased GFR are older age, high body mass index, and African/Hispanic-American ethnicity [2].

Our group has previously reported that renal function begins to stabilize at 1 month after donation, and the post-donation GFR at 12 months was 70% of the pre-donation GFR [3]. However, at 12 months after donating the kidney, there are still donors whose GFR is  $<60$  mL/min/1.73 m<sup>2</sup>. A GFR  $<60$  mL/min/1.73 m<sup>2</sup> is defined as chronic kidney disease (CKD), as it is associated with increased toxicity to drugs, metabolic and endocrine complications, and risk of cardiovascular disease and death [4]. Thus, we aimed to evaluate the long-term follow-up of donors with CKD at 1 year post-donation, whether they recover renal function or remain with CKD.

## MATERIALS AND METHODS

Kidney donors who underwent nephrectomy at the Severance Hospital from March 2006 to April 2014 were reviewed. Those with a follow-up estimated GFR (eGFR)  $<60$  mL/min/1.73 m<sup>2</sup> at the 1-year post-donation timepoint and who were followed for  $>3$  years were included in the study. All donor nephrectomies were performed using video-assisted mini-incision surgery, as previously described [5]. The donors were followed-up according to the protocol at 1 week, 1 month, 3 months, 6 months, 9 months, 1 year, and then annually. Age, sex, history of hypertension or diabetes, body mass index (BMI), blood pressure, complete blood count, preoperative routine serum chemistry, and urine study results were reviewed. The eGFR was calculated using the Modification of Diet in Renal Disease (MDRD) formula [6].

Continuous data are presented as median (interquartile range, IQR), and the differences between variables were analyzed using the Mann-Whitney *U* test for continuous variables and Pearson's chi-square test for categorical variables. The relationship between variables was analyzed using logistic regression analysis.  $P < .05$  was considered statistically significant. Statistical analyses were performed using SPSS version 20.0 (IBM SPSS, Inc, Armonk, NY).

## RESULTS

Of the 841 donors assessed during the study period, 362 had sufficient follow-up data. Among donors with sufficient data, 111 (30.6%) had eGFR  $<60$  mL/min/1.73 m<sup>2</sup> at 1 year post-donation, and the median follow-up period was 62.8 (42.0–86.3) months. The maximum eGFR after 3-year follow-up was studied and donors whose eGFR remained  $<60$  mL/min/1.73 m<sup>2</sup> were included in the

nonrecovery of renal function (NRF) group and those who recovered eGFR to  $>60$  mL/min/1.73 m<sup>2</sup> were included in the recovery of renal function (RRF) group. There were 48 (43.2%) patients included in the NRF group and 63 in the RRF (56.8%) group.

Donors in the RRF group were more likely to be younger (52.5 [47.0–55.7] vs 47.0 [7.0–53.0] years,  $P = .001$ ), have no history of hypertension (16.7% vs 1.6%,  $P = .004$ ), have higher pre-donation eGFR (76.0 [71.0–84.0] vs 81.8 [75.5–87.4] mL/min/1.73 m<sup>2</sup>,  $P = .018$ ), and have higher eGFR at 1 year post-donation (53.9 [IQR 50.3–56.0] vs 57.0 [IQR 54.2–58.4] mL/min/1.73 m<sup>2</sup>,  $P < .001$ ) (Table 1). These factors were all significant on univariate logistic regression analysis, and multivariable regression analysis of these factors was performed. Age ( $P = .007$ , OR 1.1), history of hypertension ( $P = .042$ , OR 10.0), and eGFR at 1 year ( $P = .002$ , OR 0.813) remained as significant risk factors (Table 2).

## DISCUSSION

In this study we found that 30.6% of kidney donors had a eGFR of  $<60$  mL/min/1.73 m<sup>2</sup> at 1 year after donation. Of those with a low eGFR at 1 year post-donation 43.2% were still with CKD, even after more than 3 years of follow-up. Donors who were older, with a history of hypertension, and had a lower eGFR at 1 year post-donation were more likely to have persistent CKD even after 3 years of follow-up.

The renal function of kidney donors after donation is commonly thought to be 70% of that before donation, and it has been reported by several groups that renal function improves for several years after donation [7,8]. However, as seen in our study, despite an anticipated renal function improvement after donation, about 13% of donors remained at risk of CKD even at beyond 3 years post-donation. This result raises caution as donors with CKD after kidney donation may be exposed to secondary health risks due to decreased renal function. It also highlights the importance of continued health management and counseling after donation.

The fact that age and history of hypertension were significant factors predicting donors remaining with CKD is of concern when considering that there is a current trend to expand the criteria for accepting kidney donation. To meet the demand for kidneys, transplant teams are increasingly allowing older individuals and those with health conditions such as obesity, prediabetes, kidney stones, or hypertension, to become living kidney donors [1,9]. Previous studies have reported that donors who are older and with well-controlled hypertension are not at increased risk of renal function loss [10,11]. However, we found that many patients are at risk of CKD at 1-year post-donation, and at long-term follow-up the elderly and those with underlying hypertension were more likely to remain with CKD. An increase of 10 years in age was

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