One-Year Impact of Kidney Transplantation on Cardiac Abnormalities and Blood Pressure in Hemodialysis Patients

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One-year impact of kidney transplantation on cardiac abnormalities and blood pressure in hemodialysis patients

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Abstract

Cardiac abnormalities, including left ventricular hypertrophy and systolic dysfunction, are frequently observed among patients with chronic kidney disease, including kidney transplant recipients; they are closely linked to cardiovascular disease and mortality. Although several studies have been performed for elucidating changes and mechanisms of cardiac abnormalities after kidney transplantation, details remain unclear. This study included 43 consecutive patients who underwent hemodialysis and received kidney transplantation between 2008 and 2012 at our institution. All subjects underwent echocardiography before and 1 year after kidney transplantation. One year after kidney transplantation, left ventricular mass index, cardiac chamber sizes, blood pressure, and the number of antihypertensive agents were reduced. Although the percentage of patients with concentric hypertrophy did not change, the percentage of those with eccentric hypertrophy significantly decreased after kidney transplantation. Volume reduction due to the recovery of kidney function may be primarily attributed to the improvement of cardiac abnormalities, including left ventricular hypertrophy.

Keywords: blood pressure, hemodialysis, hypertension, kidney transplantation, left ventricular hypertrophy

Introduction

It is well known that cardiovascular disease (CVD) events and mortality rate are increasing in patients with chronic kidney disease (CKD) with decreasing kidney function [1]. This applies to patients receiving kidney transplantation (KT), and the major cause of death reported in these patients is CVD [2].

It has been reported that cardiac abnormalities are frequently observed in patients with CKD, and left ventricular hypertrophy (LVH) is the most prevalent cardiac abnormalities [3]. A study reported that approximately 80 % of patients with advanced stage CKD had LVH before initiating hemodialysis [4]. Although LVH is an independent risk factor for mortality, left ventricular systolic dysfunction and left ventricular dilatation have been shown to be associated with death in patients with CKD [5]. Although kidney function is ameliorated after KT, the influence of improved kidney function on the cardiovascular system has not been fully elucidated. Several studies have examined the prevalence of CVD, change in cardiovascular abnormalities, including systolic dysfunction, LVH, and blood pressure; however, only a few studies have performed detailed evaluation of cardiac morphology and changes in blood pressure.

Therefore, the aim of the present study was to investigate changes in detailed echocardiographic parameters and blood pressure, and control of hypertension in patients undergoing hemodialysis before and one year after KT.

Materials and methods

Study design

This was a retrospective study, wherein we compared clinical characteristics including echocardiographic parameters, blood pressure, and use of antihypertensive agents before and after KT in patients undergoing hemodialysis. The study was retrospectively conducted in accordance with the Declaration of Helsinki Principles. All study protocols were approved by the appropriate institutional review committee (no. 1388).

Study population

A total of 70 patients was received kidney transplantation at our institution between 2008 and 2012. Inclusion criteria were as follows; age ≥ 20 years and undergoing hemodialysis. Exclusion criteria included those undergoing preemptive KT or peritoneal dialysis; those who did not receive echocardiography before and 1 year after KT; foreign patients; and those with insufficient clinical data. After this exclusion, the remaining 43

patients were registered in this study. The patients underwent detailed echocardiography prior to and at 1 year after KT.

Blood pressure and antihypertensive drugs use evaluation

Prior to KT, all the study patients were hospitalized and blood pressure was measured at rest by nurses twice or thrice a day. Average blood pressure measurements during one week before KT were calculated. After KT, home blood pressure was measured. The average home blood pressure measurements during one week were accepted as blood pressure one year after KT. In addition, we also evaluated the type of prescribed antihypertensive drugs and whether the type and/or doses of antihypertensive drugs were reduced or not.

Echocardiographic measurements

Echocardiography was performed at baseline and at 1 year after KT. Prior to KT, echocardiography was performed on the interdialysis day. Two-dimensional guided M-mode echocardiography was performed to measure left ventricular wall mass. Left ventricular end-diastolic and end-systolic diameter (LVDd/LVDs) as well as the diastolic thickness of interventricular septum (IVST) and left ventricular posterior wall (LVPWT)

were assessed on M-mode images in the parasternal longitudinal-axis view. M-mode analysis was performed according to the guidelines of the American Society of Echocardiography. The left ventricular mass index (LVMI) and relative wall thickness were calculated using these LVDd, LVDs, IVST, and LVPWT [6].

Statistical analysis

Data were analyzed using the IBM SPSS statistics version 23.0 (SPSS Inc., IL, USA). Values are presented as the mean ± standard deviation (SD). Paired t-tests and Wilcoxon Signed-rank test were used to analyze significant differences in clinical characteristics before and after KT. Pearson's correlation coefficient was used to analyze relationships between variables. A *p* value of less than 0.05 was considered statistically significant.

Results

Table 1 shows the clinical characteristics of the study patients before KT. Thirty-one patients were male (72.1%). The average age was 47 ± 12 years. Although the major cause of ESRD was chronic glomerulonephritis (62.8%), the details were not clearly established. Six patients (14.0%) developed ESRD due to diabetic nephropathy. The details of other causes of ESRD are shown in Table 2. The average dialysis vintage was

67 ± 90 months. Thirty-five patients (81.4%) received KT from living donors and eight patients from cadaver donors. Before KT, blood pressure, mineral bone disorder, anemia, and diabetes mellitus were well controlled for most of them. All the patients who were registered in the present study had atrial-venous fistula (AVF), and they had not received a surgery to occlude AVF or experienced spontaneous occlusion of AVF one year after kidney transplantation.

As shown in Table 3, after KT, systolic blood pressure was significantly reduced, and diastolic blood pressure also tended to be lower. Furthermore, the type of prescribed antihypertensive drugs also decreased. Among the 43 study participants, 29 patients (67.4%) took antihypertensive drugs before KT. Renin angiotensin system inhibitor was used for 23 patients (53.5%), calcium channel blocker for 14 patients (32.6%), beta-blocker for seven patients (16.3%), and alpha-one blocker for two patients (4.7%). After KT, the type and/or doses of antihypertensive drugs were significantly decreased in those taking antihypertensive drugs. Fourteen patients before and 20 after KT received no treatment for hypertension. Twenty out of 29 patients took fewer kinds and/or doses of antihypertensive drugs or no drugs after KT. However, three patients who had not taken antihypertensive drugs before KT had to start taking these drugs.

After KT, although IVST and LVPWT did not significantly change, LVDd, LVDs, and LVMI reduced significantly (Table 4). Systolic and diastolic functions were also improved. Left atrial diameter tended to decrease. Before KT, 24 patients (55.8%) had LVH; however, the number of those with LVH significantly reduced after KT (from 24 to 18 patients, $p < 0.05$). Regarding the detailed left ventricular geometry, the number of those with eccentric hypertrophy significantly decreased and the number of those with concentric remodeling significantly increased after KT although the number of those with normal geometry and concentric hypertrophy did not differ (Table 5).

Discussion

We demonstrated the following: (1) at 1 year post-KT, LVDd, LVDs, and LVMI were significantly reduced, and left atrial diameter tended to be reduced; (2) cardiac systolic and diastolic functions significantly improved after kidney transplantation; (3) as for left ventricular morphology, the percentage of patients with eccentric hypertrophy decreased significantly and the percentage of those with concentric remodeling increased significantly as a result of KT; (4) systolic and diastolic blood pressure and the number of prescribed antihypertensive drugs were significantly reduced after KT.

Many patients with CKD have LVH, and several studies have reported that LVH was improved after KT [7-12]. Reportedly, the presence of LVH was independently associated with an increased risk for graft dysfunction and future CVD in patients receiving KT [13, 14]. Therefore, the improvement of LVH after KT is very crucial for recipients of KT. However, some studies have reported that cardiac morphology, including LVH, did not change after KT [15-18]. A detailed study using cardiac magnetic resonance demonstrated that there were no significant changes in LVMI, EF, LVDd, LVDs after KT [15]. However, this study included some patients receiving preemptive KT and those undergoing hemodialysis during a relatively short period and differed from our study in several aspects. In contrast, our study included only patients undergoing hemodialysis and their dialysis vintage were longer in comparison with those in the previously mentioned study. There were also eight patients undergoing hemodialysis for more than 10 years in our study (18.6%). Most patients receiving preemptive KT had well-controlled body fluid volume and blood pressure, and, therefore, LVH did not appear to be improved after KT in the study.

Only a few studies have evaluated detailed echocardiographic parameters, and most of the studies which examined cardiac changes reported that LVDd and LVDs deceased and EF and FS were improved after KT [7, 9, 12]. However, few studies showed a

decrease in IVST and PWT after KT. There are also few studies which evaluated change in LA chamber size, and none of these studies reported significant change of in LA chamber size. The results of our study demonstrated that LVDd and LVDs significantly decreased and LA chamber size also tended to decrease at 1 year after KT. In the evaluation of LVM and LVMI using echocardiography, LVDd, LVDs, IVST, and PWT greatly affect these parameters [6]. The results of changes in left ventricular geometry in the present study showed that the percentage of concentric hypertrophy did not change and the percentage of eccentric hypertrophy significantly decreased after KT. Taken together, decrease in LVDd and LVDs, that is, normalization of body fluid volume seems to greatly contribute to the improvement of LVH. However, unfortunately, as patients new to hemodialysis and non-dialyzed patients with advanced stage CKD were not included in this study, we could not perform the comparison analysis. To resolve this issue, further studies using a larger sample size are required.

Hypertension is an important risk factor for the development of LVH and is closely linked with body fluid volume [19, 20]. Although there are several studies on changes in blood pressure after KT, the presence of hypertension and changes in blood pressure were evaluated by various methods [12, 21-26]. Some studies reported that blood pressure decreased after KT [21-24], but others reported that blood pressure rather

increased after KT [12, 25, 26]. As numerous factors such as volume status, cardiac function, use of antihypertensive agents, calcineurin inhibitors, and neurohumoral factors influence on changes in blood pressure [27, 28], it is difficult to elucidate the detailed pathophysiological mechanisms of changes in blood pressure after KT. Corresponding with the result of previous studies [29, 30], our study also showed that blood pressure and the number of antihypertensive agents decreased after KT. It is well known that cardiac output and peripheral resistance chiefly contribute to change in blood pressure. In the present study, we could not evaluate accurate body fluid volume; however, considering from the results of changes in echocardiographic parameters, decrease in body fluid volume is supposed to be one of the important factors for blood pressure. Besides, changes in the renin-angiotensin-aldosterone system, uremic toxins, oxidative stress, and sympathetic nerve activation are also related to change in blood pressure after recovery of kidney function. Improvement of endothelial dysfunction has also been suggested as one of the mechanisms of decrease in blood pressure after KT (Figure 1).

Conclusions

Our study showed that LVH, cardiac chamber dilatation and blood pressure were ameliorated at 1 year after KT. It is suggested that amelioration of body fluid status and uremic condition after KT primarily attributes to the improvement of cardiac abnormalities, including LVH.

Conflict of Interest Statement: All authors declared no conflict of interest.

This study was presented at the 15th Congress of Asian Society of Transplantation, 2017.

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Figure legend

Figure 1. Putative pathophysiology of change in cardiac abnormalities and blood pressure

Table 1. Patients characteristics before kidney transplantation

	N = 43
Sex (male/female)	31/12
Age (y.o.)	47 ± 12
SBP (mmHg)	130.1 ± 14.6
DBP (mmHg)	74.0 ± 9.2
HD vintage (months)	67 ± 90
Living KT (%)	35 (81.4)
DM (%)	6 (14.0)
Hb (mg/dL)	10.9 ± 1.5
Alb (g/dL)	3.8 ± 0.5
Ca (mg/dL)	9.3 ± 0.9
P (mg/dL)	5.7 ± 1.5
iPTH (pg/mL)	181.0 ± 154.3

SBP, systolic blood pressure; DBP, diastolic blood pressure; HD, hemodialysis; KT, kidney transplantation; DM, diabetes mellitus; Hb, hemoglobin; Alb, albumin; Ca, calcium; P, phosphate; iPTH, intact parathyroid hormone.

Values are presented as the median and interquartile or mean ± SD.

Table 2. Etiologies of end stage kidney disease

	N = 43
CGN	27
IgAN	9
FSGS	1
Unknown	17
DMN	6
Others	10
Hypoplastic kidney	3
Nephrosclerosis	1
ADPKD	1
Lupus nephritis	1
RCC	1
Unknown	3

CGN, chronic glomerulonephritis; IgAN, IgA nephropathy; FSGS, focal segmental glomerulosclerosis; DMN, diabetic nephropathy; ADPKD, autosomal dominant polycystic kidney disease; RCC, renal cell carcinoma.

Table 3. Changes in blood pressure and antihypertensive treatment

	Pre-KT	Post KT 1 year	*P*
SBP (mmHg)	130.1 ± 14.6	123.6 ± 14.0	< 0.05
DBP (mmHg)	74.0 ± 9.2	71.5 ± 9.0	n.s.
Types of antihypertensive drug	1.07 ± 1.01	0.65 ± 0.84	< 0.05
Those with antihypertensive treatment (%)	29 (67.4)	23 (53.5)	< 0.05
Decreased antihypertensive treatment (%)	-	20 (69.0)	-

KT, kidney transplantation; SBP, systolic blood pressure; DBP, diastolic blood pressure.

Values are presented as the median and interquartile or mean ± SD.

Table 4. Echocardiographic parameters before and after kidney transplantation

	Pre-KT	Post KT 1 year	*p*
LA (mm)	38.7 ± 8.6	37.0 ± 7.6	0.05
LVDd (mm)	47.7 ± 6.6	45.3 ± 5.6	< 0.05
LVDs (mm)	30.6 ± 6.2	27.4 ± 4.4	< 0.05
IVST (mm)	11.1 ± 2.1	11.0 ± 1.7	n.s.
LVPWT (mm)	11.4 ± 2.7	10.8 ± 1.8	n.s.
FS (%)	36.3 ± 6.2	39.7 ± 5.5	< 0.05
LVM (g)	247.7 ± 105.7	215.1 ± 75.9	< 0.05
LVMI (g/m^2)	150.1 ± 61.0	126.3 ± 39.7	< 0.05
RWT	0.48 ± 0.12	0.48 ± 0.08	n.s.
E/A ratio	0.93 ± 0.32	1.04 ± 0.43	< 0.05
DcT (msec)	237.9 ± 51.6	241.7 ± 68.1	n.s.
TRPG (mmHg)	20.0 ± 7.3	22.0 ± 6.7	n.s.
IVCD (mm)	10.9 ± 3.0	10.8 ± 3.6	n.s.

LA: left atrial dimension; LVDd: left ventricular diastolic diameter; LVDs: left ventricular systolic diameter; IVST: intraventricular septum thickness; LVPWT: left ventricular posterior wall thickness; FS: fractional shortening; LVM, left ventricular mass; LVMI: left

ventricular mass index; RWT: relative wall thickness; DcT: deceleration time; TRPG: tricuspid regurgitation pressure gradient; IVCD: inferior vena cava diameter.

Values are presented as the median and interquartile or mean ± SD.

Table 5. Left ventricular geometry before and after kidney transplantation

	Pre-KT	Post KT 1 year	*P*
Normal (%)	11 (25.6)	12 (27.9)	n.s.
LVH (%)	24 (55.8)	18 (41.8)	< 0.05
Concentric remodeling (%)	8 (18.6)	13 (30.2)	< 0.05
Eccentric hypertrophy (%)	10 (23.3)	5 (11.6)	< 0.05
Concentric hypertrophy (%)	14 (32.5)	13 (30.2)	n.s.

KT, kidney transplantation; LVH, left ventricular hypertrophy.

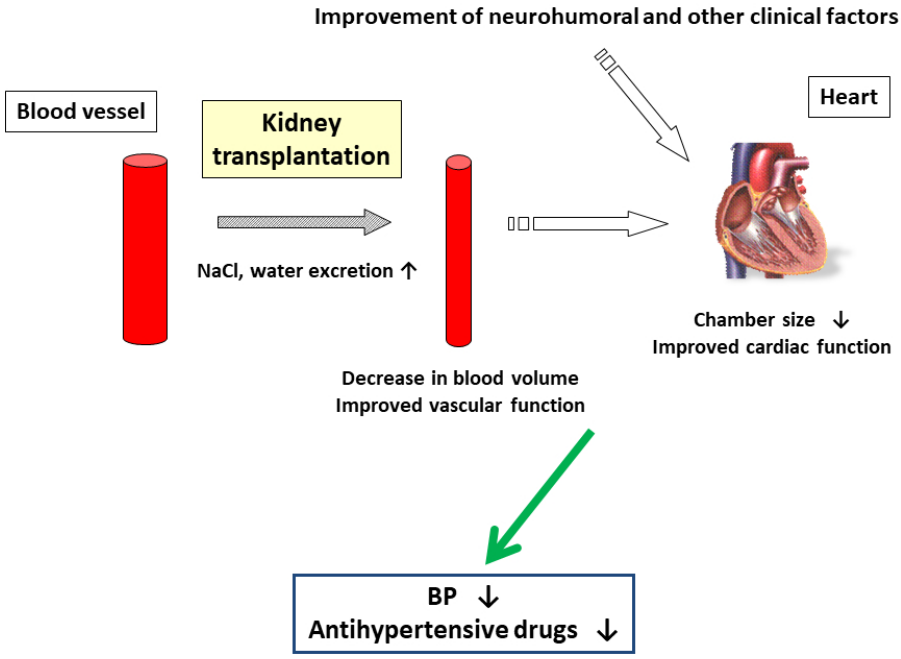

Figure 1

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