Original Article

Study of Echocardiographic Alterations in the First Six Months after Kidney Transplantation

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Abstract

Background: **Cardiac disorders are very common in individuals with chronic kidney disease and are associated with morbimortality.**

Objective: **To evaluate cardiac alterations after kidney transplantation.**

Methods: **We prospectively evaluated 40 patients with chronic kidney disease, immediately before and one month, three months and six months after kidney transplantation, using tissue Doppler echocardiographic study. The left ventricular mass, systolic and diastolic function parameters were analyzed.**

Results: **The mean age was 31.6 years and 40% of patients were female. We observed a reduction in left ventricular diastolic diameter (52.23 to 49.95 mm, $p = 0.021$) and LV mass index (131.48 to 113.039 g/m2, $p = 0.002$) after kidney transplantation. The mean E/e' decreased in the third and sixth months after kidney transplantation, when compared to basal values (8.13 and 7.85 vs. 9.79, $p < 0.05$). The ejection fraction increased from the first month after kidney transplantation compared to basal assessment (69.72% vs. 65.68%, $p < 0.05$). The prevalence of diastolic dysfunction decreased 43% during the evaluated period. The basal ejection fraction and mean E/e' were associated with reduced LV mass index after kidney transplantation. The LV mass index at baseline, female sex and decrease in serum phosphorus were associated with a reduction in the mean E/e ' ratio after kidney transplantation.**

Conclusion: **Kidney transplantation resulted in significant alterations in Doppler echocardiographic parameters of LV mass, systolic and diastolic function in patients with chronic kidney disease. (Arq Bras Cardiol 2012;98(6):505-513)**

Keywords: **Kidney diseases / complications; kidney failure, chronic; kidney transplantation / mortality; echocardiography doppler.**

Introduction

Cardiac disorders are very common in individuals with Chronic Kidney Disease (CKD). According to Foley et al[1], approximately 75% of individuals with CKD who start dialysis have left ventricular hypertrophy (LVH), left ventricle (LV) dilatation or reduced LV fractional shortening, and these cardiac abnormalities continue to progress in the first year of dialysis[2]. In addition to these alterations, impairment of diastolic function is also common in these patients[3].

Cardiovascular disease is the leading cause of mortality in patients with CKD, undergoing dialysis and accounts for approximately half of all deaths in these patients. Data from the United States Renal Data System 2010 Annual Data Report[4] demonstrated that cardiovascular disease represents approximately 50% of the causes of death, regardless of the duration of dialysis.

Currently, with the improvement in surgical techniques and immunosuppressive therapy, kidney transplantation has been considered the standard treatment for patients with end-stage CKD, resulting in reduced mortality compared to dialytic treatment[5]. This improvement in survival after kidney transplantation can be partially attributed to improvement in cardiac function.

Echocardiography has developed in recent years, with the emergence of new concepts and parameters to evaluate LV systolic and diastolic functions. Modern quantitative methods to evaluate myocardial disease, including estimated tissue velocity, have allowed the identification of subclinical LV dysfunction[6].

The new parameters for assessing cardiac function are widely available and easy to perform during the echocardiogram. However, studies using these new echocardiographic techniques by comparing the evolution of cardiac alterations before and after kidney transplantation are scarce and consist of small samples. The objective of this study was to evaluate, by means of echocardiography, the morphological and functional heart alterations within the first six months after kidney transplantation.

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Methods

We performed a prospective study of patients from the kidney transplantation unit at Hospital Universitário da Universidade Federal do Maranhão (HUUFMA). All patients of both sexes, regardless of age, referred for kidney transplantation in HUUFMA from March 2008 to April 2010 were consecutively included in the study. Patients with deceased donors or those who did not agree to participate in the study were excluded. Patients who did not perform all echocardiogram assessments were excluded from the final analysis.

Data collection

Immediately before each Doppler echocardiography, height and weight measurements were performed, providing the Body Mass Index (BMI = weight/height^2) and Body Surface Area (BSA) by the formula of Du Bois[7] of each patient included in the study. The clinical and laboratory data of each patient before and six months after kidney transplantation were obtained from medical records.

Doppler Echocardiogram

Echocardiographic examination was performed in all patients before kidney transplantation (baseline) and one month, three months and six months after transplantation. All echocardiographic assessments were performed by the same professional using a GE Vingmed ultrasound machine, model Vivid 3 (Horten, Norway), with the second harmonic and sector transducer of 2-4 MHz.

The measurements were performed according to the American Society of Echocardiography[8]. The measurements obtained directly in the M-mode by the two-dimensional image included: Left Atrial Diameter (LAD), left ventricular diastolic diameter (LVDD), LV systolic diameter (LVSD), LV posterior wall (LVPW) and Interventricular Septum (IVS) thickness. Using the M-mode linear measurements, the following parameters of LV systolic function were calculated: LV fractional shortening (ΔD), LV ejection fraction (LVEF) estimated by the Teichholz method and the LV end-systolic volume index (LVESVi), dividing the LV end-systolic volume by the BSA. The left atrial volume was calculated from the measurement of three orthogonal diameters as proposed by Pritchett et al[9] and indexed to body surface area.

To calculate Left Ventricular Mass (LVM), the following formula was used: $LVM = 0.8\ [1.04\ (IVSD + + LVDD + LVPWD)^3 - (LVDD)^3] + 0.6$. Indexation of LV mass by height to the power of 2.7 was a more robust predictor of mortality and cardiovascular events in patients with CKD and dialysis when compared to indexing by BSA[10]; thus, for the indexing of ventricular mass and calculation of the presence of Left Ventricular Hypertrophy (LVH), two criteria were used, resulting in the parameter LVM/BSA and the parameter LVM/height $^{2.7}$. LVH by the LVM / BSA was considered when > 95 g/m^2 for women and > 115 g/m^2 for men. LVH was also considered by LVM/height $^{2.7}$ when > 44 g/m $^{2.7}$ for women and > 48 g/m $^{2.7}$ for men.

The Doppler study was performed following the recommendations of the American Society of Echocardiography[11]. The Doppler measurements were obtained through the mean of three consecutive cycles with a velocity of 50 mm/s. The pulsed Doppler analysis was performed using the following measures: the peak velocities of E and A waves and the E/A ratio were calculated; deceleration time of E wave (DTE) and isovolumetric relaxation time (IVRT). The Myocardial Performance Index (MPI) was obtained from the ratio of the sum of the times of isovolumetric contraction and relaxation by aortic ejection time[12].

The analysis of tissue Doppler was performed using the appropriate configuration of the echocardiography equipment. The pulsed Doppler volume sample was positioned at the lateral mitral annulus and septal mitral annulus in the apical four-chamber view, yielding measurements of the peak velocities of the e′ and a′ waves in each annulus. Based on these data, we calculated the mean ratio of mitral inflow E-wave and e′ wave at the tissue Doppler (E/e′), obtained from the arithmetic mean of the E/e′ ratio of the two annuli.

The evaluation of diastolic function was performed in accordance with the recommendations for the practical management of diastolic dysfunction grading by the American Society of Echocardiography[13]. Initially, patients who showed septal e′ wave < 8 cm/s or lateral e′ < 10 cm/s or LA volume index ≥ 34 mL/m^2 were characterized as having diastolic dysfunction. Then, diastolic dysfunction was classified as grade I (E / A ratio < 0.8 and mean E/e′ ≤ 8), grade II (E/A ratio ≥ 0.8 and < 2 and mean E/e′ > 8 and < 13) and grade III (E/A ratio ≥ 2 and E/e′ ≥ 13).

The study was approved by the Ethics and Research Committee of HUUFMA, protocol # 284/09 and each patient was informed and instructed about the study and signed the Free and Informed Consent Form.

Statistical Analysis

Quantitative data were expressed as mean and standard deviation (mean ± SD) and qualitative data as absolute and relative frequency. Analysis of variance (ANOVA) was used to compare the quantitative variables for repeated data when appropriate or nonparametric Friedman test. The normality of quantitative variables was analyzed by the Shapiro Wilk's test. The post-test analysis to evaluate the differences of means between moments in time was performed by Bonferroni test. Cochran's test was used to compare the qualitative variables and when there was a significant difference, McNemar's test was used to compare proportions between each moment.

To verify the association between clinical and laboratory variables and the presence of echocardiographic alterations, the longitudinal linear regression model was used. We considered two regression models. In the first model, the dependent variable was the LVM/ BSA and the second considered the mean E/e ′ ratio. In both models, the independent variables were sex, age, duration of dialysis, systolic blood pressure, diastolic blood pressure, hemoglobin, creatinine, urea, phosphorus, calcium and basal LVEF. The basal LV mass index was included as an independent variable only in the second model and the basal E/e′ ratio was included in the first model. Variables with p-value < 0.10 were considered in the multivariate longitudinal linear regression model. The significance level was set at 5%. The data were analyzed using the statistical software STATA 10.0.

Results

A total of 51 patients were selected from March 2008 to April 2010, and 11 patients did not undergo the four echocardiograms, resulting in a final sample of 40 patients with a mean age of 31.6 (± 12.7) years and mean BMI of 21.49 (± 3.49) kg/m^2, of which 40% were women. The clinical and laboratory characteristics before and six months after kidney transplantation are shown in Table 1.

Echocardiographic parameters in the M-mode

The structural echocardiographic parameters evaluated by M-mode are shown in Table 2. There was no statistically significant difference in LA diameter during the study period. There were significant differences in LVDD in the study period (p = 0.021), and this is the most important difference between baseline (52.23 mm) and six months after renal transplantation (49.95 mm). Regarding myocardial thickness, we observed a decrease from the third month after renal transplantation, with a statistically significant difference between the mean thickness of the IVS and LVPW one month and six months after kidney transplantation, but no significant decrease in relation to baseline assessment.

The LVM, regardless of the criterion of correction used (body surface area or height), decreased progressively from the first month after kidney transplantation (Table 2). We observed a significant difference in the evaluation performed six months after kidney transplantation compared to baseline and in relation to the assessment in the first months after the transplantation.

The diagnosis of LVH using the criterion of correction for body surface area or height showed high frequency in the baseline assessment (> 60%) and a slight and non-significant

Table 1 – **Patients' clinical and laboratory parameters before and six months after kidney transplantation**

Clinical and Laboratory Characteristics	Before	After	p-value
Casual SBP in mmHg, mean ± SD	128,70 ± 24,06	115,25 ± 11,98	0,003
Casual DBP in mmHg, mean ± SD	84,75 ± 18,53	74,00 ± 9,00	0,001
Creatinine in mg/dl, mean ± SD	8,69 ± 3,36	1,45 ± 0,43	< 0.001
Urea in mg/dl, mean ± SD	105,02 ± 39,00	39 ± 15,03	< 0,001
Hemoglobin in mg/dL, mean ± SD	11,43 ± 1,90	12,21 ± 2,11	0,07
Serum phosphorus in mg/dL, mean ± SD	5,07 ± 1,76	3,49 ± 0,77	< 0,001
Hypocalcemia, n (%)	10 (25)	3 (7,5)	0,04

SBP – systolic blood pressure; DBP – diastolic blood pressure; SD – standard deviation.

Table 2 – **Evolution of echocardiographic, structural and functional parameters of patients submitted to kidney transplantation**

	Basal Mean (± SD)	1 month Mean (± SD)	3 months Mean (± SD)	6 months Mean (± SD)	p-value
LA (mm)	39.03 (± 5.43)	38.98 (± 4.59)	37.90 (± 3.67)	38.00 (± 4.21)	0.248
IVS (mm)	10.58 (± 1.6)	10.60 (± 1.6)	10.10 (± 1.5)	9.93(± 1.8)†	0.007
LVPW (mm)	9.90 (± 1.4)	10.12 (± 1.4)	9.80(± 1.2)	9.55(± 1.4)†	0.029
LVDD (mm)	52.23 (± 7.02)	50.62 (± 5.17)	50.98 (± 5.89)	49.95 (± 5.66)*	0.021
LVM/BSA (g/m^2)	131.48 (± 38.93)	126.41 (± 29.45)	120.81 (± 30.73)	113.03 (± 29.99)*†	0.002
LVM/Ht$^{2.7}$(g/m$^{2.7}$)	57.16 (± 16.29)	54.53 (± 12.33)	52.68 (± 14.41)	49.74 (± 14.52) *†	0.008
E wave (cm/s)	90.74(± 25.53)	84.25(± 19.85)	81.49(± 22.53)*	81.13(± 17.69)*	0.002
E/A Ration	1.31 (± 0.52)	1.22 (± 0.38)	1.23 (± 0.51)	1.29 (± 0.40)	0.38
EDT (ms)	200.60(± 41.86)	221.07(± 40.40)	212.08(± 41.06)	224.35(± 45.38)*	0.009
IVRT (ms)	94.66(± 19.45)	98.08 (± 18.31)	99.58(± 20.90)	93.21 (± 15.46)	0.37
MPI	0.47 (± 0.15)	0.46 (± 0.11)	0.44 (± 0.12)	0.44 (± 0.10)	0.25
Diastolic dysfunction, n (%)	23 (57.5)	23 (57.5)	17 (42.5)	13 (32.5) *†	0.02
LAVi in ml/m^2, mean (± SD)	25.34(± 10.41)	24.60(± 6.39)	23.83(± 6.24)	22.04(± 4.90)	0.38

LA – left atrium; IVS - interventricular septum; LVPW – left ventricular posterior wall; LVDD – left ventricular diastolic diameter; LVM/BSA – left ventricular mass corrected by body surface area; LVM/Ht$^{2.7}$ – left ventricular mass corrected by height; SD – standard deviation; E/A ratio- E wave/A wave ratio of mitral flow; EDT – E wave deceleration time; IVRT – isovolumetric relaxation time; MPI – myocardial performance index; LAVi – left atrial volume index. (*) p < 0.05 in relation to basal values; (†) p < 0.05 in relation to one-month assessment after kidney transplantation.

increase after one month after the kidney transplantation with progressive reduction in the third and sixth months afterward. There was a statistically significant difference in the frequency of diagnosis of LVH/ BSA from the first to the sixth month after kidney transplantation (p = 0.039), and in the frequency of diagnosis of LVH corrected by height from the first for the third month (p = 0.016) and in relation to the sixth month (p = 0.002) after the transplantation (Figure 1).

Doppler Flow Velocity

The Doppler parameters of evolution are shown in Table 2. The peak E wave velocity decreased progressively from the baseline assessment with a significant difference at three (p = 0.014) and at six months (p = 0.006) after the kidney transplantation in relation to the baseline assessment. There were no significant differences in the analysis of E/A ratio and IVRT in the study period. There was a statistically significant difference in the analysis of EDT with a reduction at six months (p = 0.035) after the transplantation in relation to baseline EDT.

Regarding the MPI, despite the downward trend until the third month after the transplantation, there was no statistically significant difference in the study period (p = 0.25).

Tissue Doppler

Tissue Doppler analyses in the septal and lateral mitral annulus are shown in Figure 2. The mean amplitude of the e' wave in the lateral mitral annulus showed no significant increase from the baseline assessment to the that performed at six months (p = 0.06), but when the e' wave value was assessed in the septal mitral annulus, there was a significant increase six months after kidney transplantation in relation to the baseline assessment (p = 0.017) and in relation to that performed one month after transplantation (p = 0.018). With respect to the amplitude of a' wave, there was no significant difference either in the lateral mitral annulus, or the septal mitral annulus in all four moments assessed.

The mean E/e' ratio showed a progressive decrease in mean values during the assessed period, as shown in figure 2. There was a significant difference in the mean basal E/e' ratio in relation to the assessment at three months (p = 0.001) and at six months (p < 0.001) after kidney transplantation and also a significant difference in the mean E/e' ratio after one month in relation to the three-month (p = 0.002) and six-month assessment after the transplantation (p = 0.001).

Systolic function

The systolic function parameters analyzed in this study are shown in Figure 3. The means of the systolic function parameters evaluated in this study were within normal values at baseline assessment. There was a significant increase in LVEF and fractional shortening and a decrease in LVESVi one month, three months and six months after kidney transplantation compared with the baseline assessment.

Diastolic function

At the baseline examination, 23 patients (57.5%) met the criteria for the diagnosis of diastolic dysfunction, with 4 patients grade I, 18 grade II and 1 grade III. This diagnosis remained unchanged in the first month after kidney transplantation with nonsignificant reduction at three months after transplantation. At six months, 13 patients (32.5%) met the criteria for this diagnosis, with 3 patients grade I and 10 grade II. There was a significant decrease in the frequency of diastolic dysfunction six months after the transplantation (p = 0.006), when compared to the baseline assessment and one month after the transplantation (p = 0.03). Regarding the LA volume index (LAVi), in spite of a decrease up to the sixth month after the transplantation, it did not reach statistical significance (Table 2).

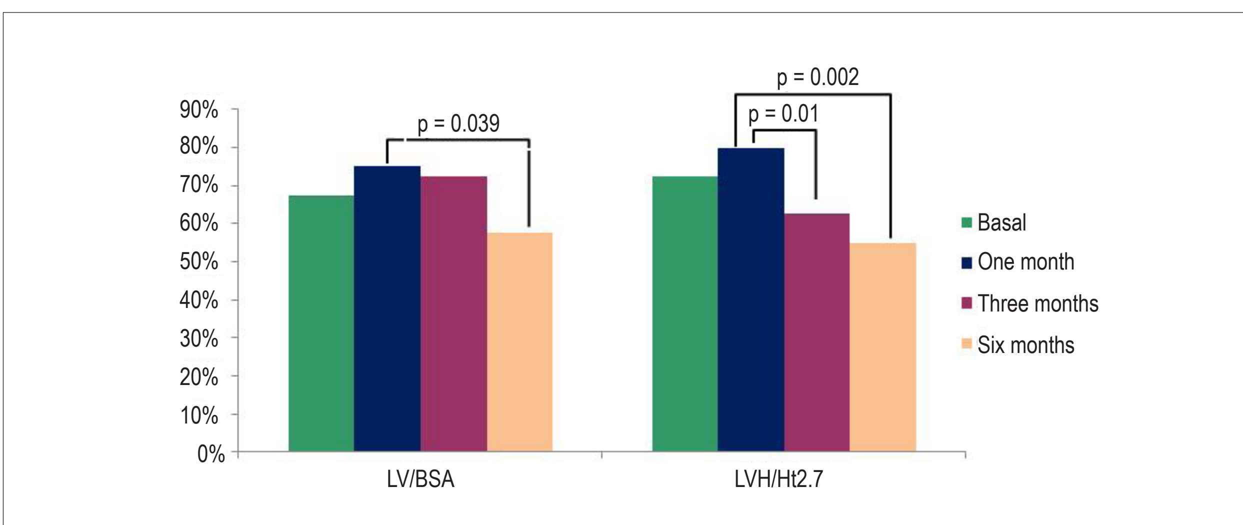

Figure 1 - *Distribution of LVH diagnosis of patients submitted to kidney transplantation. LVH/BSA - left ventricular hypertrophy corrected by body surface area LVH/ Ht2.7 - left ventricular hypertrophy corrected by height.*

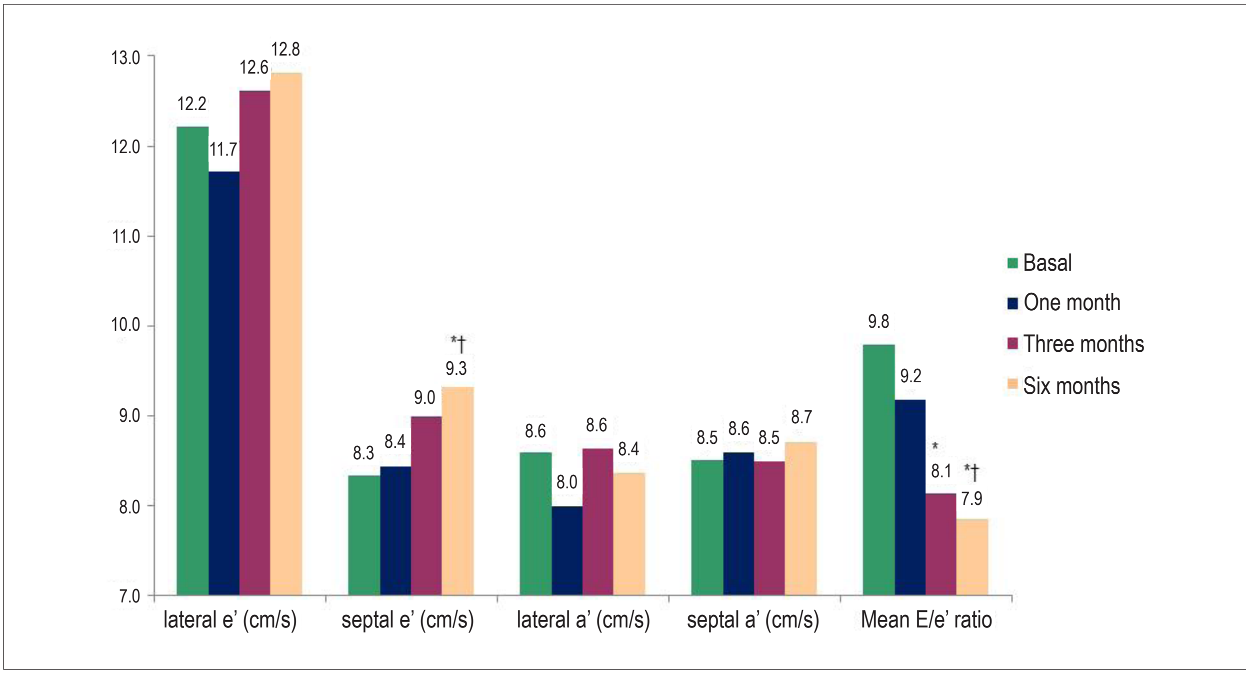

Figure 2 – *Distribution of the parameters of tissue Doppler of patients submitted to kidney transplant (*) p < 0.05 in relation to basal assessment (†) p < 0.05 in relation to assessment one month after kidney transplantation.*

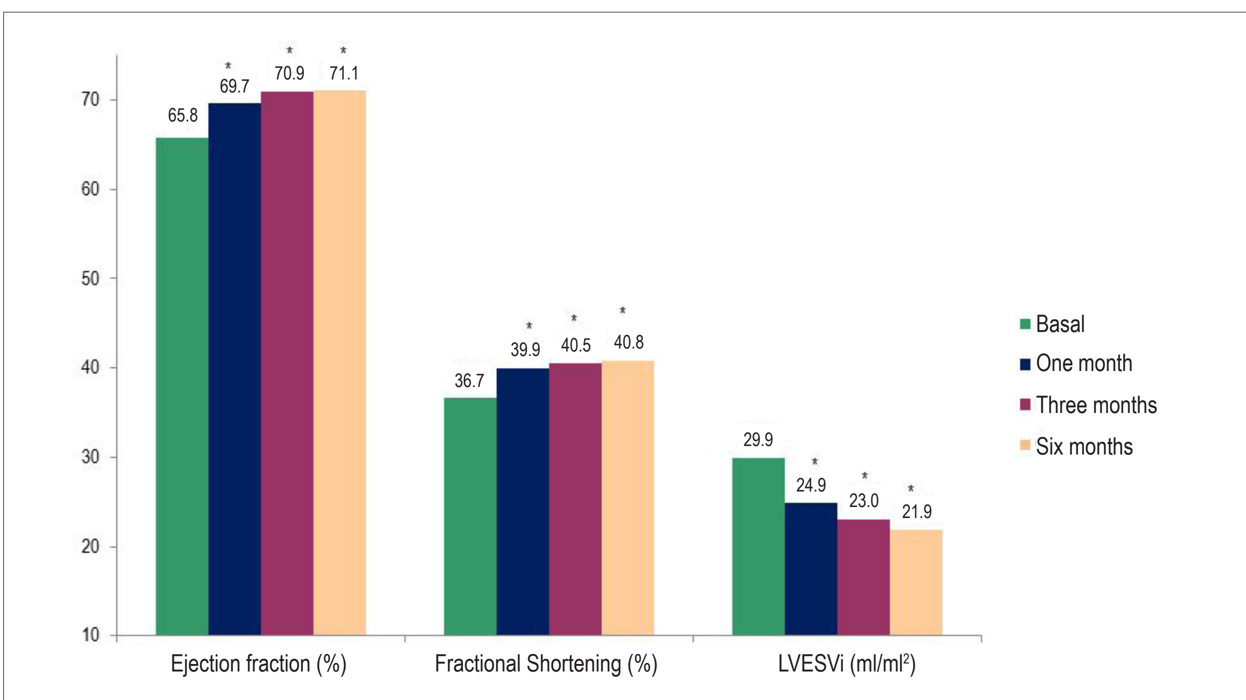

Figure 3 – *Distribution of the parameters of LV systolic function in patients submitted to kidney transplantation - LVESVi – Left Ventricular End-Systolic Volume Index. (*) p < 0.05 in relation to basal assessment.*

Factors associated with echocardiographic alterations

The decrease in SBP, DBP, creatinine and urea at six months after the transplantation, as well as the basal E/e′ ratio and LVEF were significantly associated with a decrease in LVM/BSA six months after the transplantation at the univariate analysis, as shown in Table 3. However, at the multivariate analysis, only basal echocardiographic variables (basal LVEF and E/e′ ratio) were independent predictors of reduced LVM / BSA after transplantation.

Data from the regression analysis of variables that predicted alterations in tissue Doppler are shown in Table 4. At the univariate analysis, female gender, basal LVM/BSA, longer duration of pre-transplantation dialysis and creatinine six months after transplantation were significantly associated with a decrease in the mean E/e′ ratio six months after transplantation. However, at the multivariate analysis, female gender, the basal LVM/BSA and decrease in phosphorus six months after transplantation were independent predictors of reduction in the E/e′ ratio six months after transplantation.

Discussion

Structural and functional cardiac alterations are very common in CKD patients [1] and are associated with morbimortality[14,15]. This study evaluated the echocardiographic alterations in the first six months after kidney transplantation.

There was a significant decrease in LVDD six months after transplantation, but the LA diameter showed no significant reduction in the assessed period. Iqbal et al[16] demonstrated early decrease in three months and late one-year decrease in LVEDD and LA diameter, which have been reproduced more recently by Casas-Aparicio et al[17], who also demonstrated a decrease in these diameters one year after kidney transplantation.

We observed a high prevalence of LVH, whether correcting for body surface area (67.5%), or by height (72.5%) at baseline examination prior to kidney transplantation in this study, which is in agreement with literature data demonstrating a prevalence of LVH ranging from 60% to 70% in patients that start dialysis[18]. There was also a decrease in the prevalence of LVH six months after the transplantation, but without statistical significance when compared to baseline assessment.

Also regarding the LVM after kidney transplantation, the data are not uniform in the literature. McGregor et al[19] evaluated 67 patients four months after kidney transplantation and showed no impact on ventricular mass, and Patel et al[20], in a cross-sectional study, also showed no difference in LV mass measured by magnetic resonance imaging in transplanted

Table 3 – Analysis of univariate and multivariate longitudinal linear regression: predictors of reduction in LVMi/BSA six months after kidney transplantation

Variable	Univariate		Multivariate	
	Coefficient	p-value	Coefficient	p-value
Basal ejection fraction	-1.51	0.005	-1.12	0.03
ΔDBP	0.65	0.009	0.61	0.23
ΔSBP	0.46	0.017	-0.06	0.88
ΔCreatinine	2.19	0.015	1.34	0.33
ΔUrea	0.21	0.016	0.06	0.64
Basal E/e′ ratio	2.83	0.015	2.78	0.014

SBP – Systolic Blood Pressure; DBP – Diastolic Blood Pressure; Δ - Variation of the mean before and 6 months after kidney transplantation.

Table 4 – Analysis of univariate and multivariate longitudinal linear regression: predictors of reduction in the E/e′ ratio six months after kidney transplantation

Variable	Univariate		Multivariate	
	Coefficient	p-value	Coefficient	p-value
Female/male sex	2.63	< 0.001	2.97	< 0.001
Basal LVM/BSA	0.02	0.005	0.039	< 0.001
Time of dialysis	0.035	0.027	0.011	038
Creatinine 6 months after transplantation	-1.54	0.043	0.04	0.95
ΔPhosphorus	0.39	0.05	0.31	0.046
Basal ejection fraction	-0.08	0.056	-0.01	0.77

LVM/BSA – left ventricular mass corrected by body surface area; Δ - Variation of the mean before and 6 months after kidney transplantation.

individuals and individuals undergoing dialysis. In turn, some studies have shown a decrease in LVM after kidney transplantation[21,22], even in the pediatric population[23].

In our population, we observed a progressive reduction in LVM after the first month of kidney transplantation, either corrected by BSA, or by height during the study period.

The myocardial performance index has been considered a sensitive indicator of the severity of myocardial dysfunction[12,24] and has prognostic significance in several heart disorders[25,26]. There are no previous data evaluating this index in kidney transplantation population. In our study, we observed a nonsignificant trend of progressive reduction of MPI up to the third month of kidney transplantation.

The LV systolic function is considered an independent predictor of cardiac events, both fatal and nonfatal[27] and mortality in patients with CKD and LVH[28]. Overall, there was an increase in LVEF and reduction of cavity volumes after transplantation[19,21], even in the pediatric population[23]. Moreover, Rakhit et al[29], during a median follow-up of 4.2 years after kidney transplantation showed significant reduction in LVESVi of 33 ml/m^2 to 23 ml/m^2. In our study, the mean LVEF was normal at baseline assessment and only one patient had LVEF < 55%. Similar to the literature data, we observed early (within a month of transplantation) and significant alterations in parameters of systolic function and this progressed up to the sixth month after transplantation.

Tissue Doppler is less sensitive to alterations in preload, being important in the categorization of LV diastolic function[11] and is an independent predictor of death and cardiovascular events in patients with CKD[29,30]. The only study that evaluated the evolution of tissue Doppler before and after kidney transplantation showed that the e′ wave increased significantly from 5.6 cm/s to 6.5 cm/s in a follow-up of 4.2 years[29], indicating an improvement of diastolic function. In the present study, we observed a significant improvement in diastolic function characterized by increased e′ wave, especially when evaluated in the septal mitral annulus and significant reduction of mean E/e′ ratio three months after transplantation, with additional reduction after six months.

The prevalence of diastolic dysfunction by echocardiography in patients with CKD undergoing dialysis ranges from 34% to 77%, depending on the criteria used for its quantification[3,17]. We used the recommendations of the American Society of Echocardiography[13] and observed a high frequency at baseline assessment (57.5%) in this study; after six months of transplantation, there was a significant 43% reduction of this frequency, when compared to baseline assessment. Studies carried out without the use of tissue Doppler have not demonstrated the impact of kidney transplantation on diastolic function[22,31]; however, a recent study using tissue Doppler as a criterion for the quantification of diastolic function showed similar results to the ones of the present study[17].

The assessment of the left atrium is important in the diagnosis of the severity of diastolic blood pressure and magnitude of the left atrial pressure[8]. The estimation of left atrial volume by echocardiography is an independent predictor of death and cardiovascular events in patients with CKD undergoing dialysis[28,32]. There have been no previous data evaluating the evolution of left atrial volume after kidney transplantation. This study showed a progressive decrease in the left atrial volume index within the six months of transplantation, without, however, statistical significance.

Some studies in literature have shown that clinical and laboratory factors may be associated with cardiac alterations after kidney transplantation. Ferreira et al[22] demonstrated, at the multivariate analysis, that the level of creatinine and systolic pressure load evaluated 12 months after kidney transplantation were independent predictors of LVM/BSA in the same period after the transplantation. El-Husseini et al[33] studied 75 children and adolescents 4.6 years after kidney transplantation and concluded that longer pre-transplantation dialysis time, arterial hypertension and post-transplantation anemia were independent predictors of LVH after the transplantation.

In the present study, it was observed that the pre-transplantation LVEF and E/e′ ratio were independently associated with a reduction in LVH after kidney transplantation and basal LVM/BSA was associated with a reduction in the mean E/e′ ratio after the transplantation, indicating that the greater the LV impairment before the transplantation, the greater the reduction in LVM and improvement in diastolic function after the transplantation.

Moreover, regarding diastolic function, it was observed that the female sex and the decrease in serum phosphorus were independently associated with a reduction of the mean E/e′ ratio after kidney transplantation, indicating that these variables predict an improvement in diastolic function after transplantation. The mean basal E/e′ ratio was higher in females than in males (11.6 *vs*. 8.55), so this group showed greater reduction in the E/e′ ratio at follow-up. Serum phosphorus levels are a potent stimulator of vascular calcification process[34] that may cause increased arterial stiffness; that, in turn, increases pulse pressure with a consequent reduction in coronary perfusion[35], which perhaps could explain the improvement in diastolic function with a reduction in serum phosphorus.

Study Limitations

The sample size may be a limitation, especially in the evaluation of possible associations of clinical and laboratory variables with echocardiographic alterations.

The post-transplantation follow-up period was only six months and some alterations, such as ventricular mass, may take longer to occur. But significant changes were observed even within the short monitoring period.

Conclusion

Based on these data, we conclude that kidney transplantation determined ventricular mass reduction, improvement in parameters of systolic and diastolic function in the first six months after the transplantation. The mean baseline ejection fraction and E/e′ were predictors of reduction in LVM, whereas baseline LVM/BSA, female sex and the reduction in serum phosphorus levels were associated with improvement in diastolic function parameter, and mean E/e' ratio.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

Sources of Funding

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Study Association

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