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Research Article

Effects of Renal Transplantation on Cardiac Morphology and Function Luis Vernaza Hospital, Guayaquil, Ecuador: Kidney Transplant and Morphology and Cardiac Function

Paola Alprecht-Quiroz[1], Byron Zúñiga Pineda[2,4], Joffre J. Lara-Terán[3], Silvia V. Cáceres-Vinueza[4] and Yan C. Duarte-Vera[4,5,6*]

[1]*Departamento de Medicina Interna del Hospital Luis Vernaza, Guayaquil, Ecuador*
[2]*Servicio de Nefrología del Hospital Luis Vernaza, Guayaquil, Ecuador*
[3]*Servicio de Cardiología del Hospital Juan Tanca Marengo, Guayaquil, Ecuador*
[4]*Facultad de Ciencia Medicas de la Universidad de Guayaquil, Guayaquil, Ecuador*
[5]*Servicio de Cardiología del Hospital General Luis Vernaza, Guayaquil, Ecuador*
[6]*Departamento de Investigación y Docencia Sociedad Ecuatoriana de Cardiología, Núcleo Guayas, Ecuador*

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ABSTRACT

Introduction: Structural heart disease is a frequent complication of advanced chronic kidney disease and the leading cause of death in patients with renal replacement therapy, mainly in those on dialysis. There is sufficient evidence to demonstrate a regression of left ventricular hypertrophy and improvement of ventricular function after a successful renal transplant. The objective of this study is to describe the experience regarding the effects of renal transplantation on cardiac remodeling and function and thus corroborate with local data the benefits of renal transplantation on the left ventricular mass index (LVMI grs), Left Ventricle Ejection Fraction (LVEF %), Left Atrium Diameter (LAD mm), Left Ventricle Diastolic Diameter (LVDD mm), Left Ventricle Systolic Diameter (LVSD mm), Posterior Wall (PW mm) and Interventricular Septum (IVS mm).

Materials and Methods: This is a quantitative, observational, descriptive and retrospective study. A database was constructed whose information was tabulated and subsequently analysed by the statistical program SPSS 13 to perform the statistical analysis. The results of the nominal variables were expressed in percentages and of the numerical variables in average ± standard deviation (SD) and confidence interval. The study included all adults over18 years with a diagnosis of chronic renal failure who underwent renal transplantation at Luis Vernaza Hospital between January 2009 to December 2016 and who had pre and post-transplant transthoracic echocardiography.

Results: Of the 132 adults undergoing renal transplantation, 74 patients who met the inclusion criteria were identified, their average age was 35.2 years DS (+/- 11.7 years), forty-eight patients (64%) were male. All patients were dependent on dialysis, whose average time was 5 years and 88% of the population underwent intermittent hemodialysis weekly. The pre-transplant and post-transplant echocardiographic measurements were: LVEF (%) 60.89 ± 1,175 vs. 66.81 ± 0.685 (<0.0001); LVMI (grs) 242.54 ± 11.92 vs. 184.62 ± 7,591 (<0.0001); LAD (mm) 35.9 ± 0.772 vs. 34.8 ± 0.602 (0.215); LVDD (mm) 47.97 ± 0.756 vs. 44.98 ± 0.927 (0.003); LVDS (mm) 29.85 ± 0.897 vs. 26.68 ± 0.681 (0.004); PW (mm) 11.86 ± 0.270 vs. 10.92 ± 0.208 (0.002); IVS (mm) 12.12 ± 0.348 vs. 10.95 ± 0.253 (0.002) respectively.

Conclusion: In this study, was observed a favorable overall impact of renal transplantation on the structure and function of the heart, with a significant reduction in LVH and LVMI and systolic and diastolic function of the left ventricle, thus reducing the risk of associated death to cardiovascular events.

**Correspondence to: Yan C. Duarte-Vera, Facultad de Ciencia Medicas de la Universidad de Guayaquil, Servicio de Cardiología del Hospital General Luis Vernaza, Departamento de Investigación y Docencia Sociedad Ecuatoriana de Cardiología, Núcleo Guayas, Guayaquil, Ecuador; E-mail: yancarlos_duartevera@yahoo.es; yanduartev@ug.edu.ec*

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Introduction

Heart disease is a common complication of advanced chronic kidney disease and the leading cause of death in patients with renal replacement therapy. Alterations in heart morphology and function are very common in individuals with chronic kidney failure, mainly in those on dialysis. There is sufficient evidence to show a regression of left ventricular hypertrophy and improvement of ventricular function after a successful kidney transplant. For this reason kidney transplantation has become in recent years in the best therapeutic alternative in the treatment of chronic end-stage renal failure by significantly improving the quality and life expectancy of the kidney disease compared to replacement therapy [1, 2].

The echocardiogram is a fundamental tool in pre-transplant and post-follow-up assessment, as it is a non-invasive, inexpensive, and highly available study to evaluate heart structure and function by meeting various techniques of ultrasound in a single examination, although inter-observer variability may occur. The objective of this study is to describe the experience in the effects of kidney transplantation on heart remodeling, function, and thus corroborate with local data the benefits of renal transplantation on ventricular mass, and systolic, and diastolic function of the left ventricle. A study published in the Journal of the American College of Cardiology showed a favourable overall impact of kidney transplantation on heart structure and function with the corresponding improvement in the survival of this group of patients [3]. In this study, both pre and post-transplant echocardiograms were revised to assess changes in cardiac structure and function after kidney transplantation.

Methods

I Research Hypothesis

The effects of kidney transplantation on the heart is to decrease the mass index of the left ventricle and achieve a significant improvement in systolic and diastolic heart function.

II Objective General

Identify by echocardiography changes in cardiac morphology and function post kidney transplantation.

III Specific Objectives

Know the risk factors and the main causes of chronic renal failure in patients undergoing kidney transplantation at Luis Vernaza Hospital. Determine the most common pre and post kidney transplant echocardiographic findings. Identify the prognostic factors associated with cardiac remodeling.

IV Place of Research

The study was carried out at the Luis Vernaza General Hospital, a fourth-level hospital located in the city of Guayaquil-Ecuador, which has clinical, surgical and intensive care areas. Since 2009, the hospital has the Organ and Tissue Transplant Unit, accredited by the relevant government agencies.

V Participants

The study included all adults over the age of 18 diagnosed with chronic kidney failure who underwent kidney transplantation at Luis Vernaza Hospital between January 2009 and December 2016 who had transthoracic echocardiogram pre and post-transplant. 74 patients who met the inclusion criteria were identified. The general characteristics are noted in (Table 1).

Table 1: General characteristics.

Age	Average (years)	35.2 ± 11,7
Sex	Male (%)	48 (64)
	Female (%)	26(36)
Comorbidities' (%)		
	Diabetes	1(1,4)
	High blood pressure	68 (91,9)
	Dyslipidemia	3 (4,1)
	Alcohol	8 (10,8)
	Tobacco	4 (5,4)
	Coronary heart disease	3 (4,1)
	Stroke event	1 (1,4)
Cause of chronic kidney disease (%)		
	High blood pressure	9(12,2)
	Glomerulonephritis	11 (14,9)
	Poliquistosis renal	5 (6,8)
	Alport syndrome	1 (1,4)
	Unknown	43 (58,1)
	Kidney agenesis	1 (1,4)
	Other	4 (5,4)
Dialysis modality (%)		
	Hemodialysis	65(88)
	Peritoneal dialysis	9(12)
Years in dialysis (%)		
	1 year	2 (3)
	2 years	4 (5)
	≥ 3 years	68 (92)
Type of donor (%)		
	Cadaveric Donor	66(89)
	Living Donor	8(11)
Mortality (%)		
	Alive	73 (99)
	Dead	1 (1)

VI Inclusion Criteria

i. Older 18 years with diagnosis of chronic kidney failure undergoing kidney transplantation.
ii. Pre and post-transplant echocardiogram report.

VII Exclusion Criteria

i. Lack of data in medical history.
ii. Death during kidney transplant.
iii. Rejection of transplanted organ.

VIII Variables Studied

Medical records of the electronic medical history of Nephrology Service database, from January 2009 to December 2016, were reviewed retrospectively. A record sheet was prepared in the Excel program to obtain the following variables: demographic data such as age and gender; high blood pressure, diabetes mellitus, dyslipidemia, coronary artery disease, heart failure, cardiovascular events; cause of chronic kidney disease; duration of renal failure and time undergoing dialytic treatment; estimated glomerular filtration rate; hemoglobin and echocardiographic findings before and after kidney transplantation. Echocardiographic parameters were defined based on the contributions of the American Echocardiography Guide with the following definitions:

i. Mild systolic dysfunction: LVEF: 51% for men and 53% for women, but > 40 % for both sexes.
ii. iModerate dysfunction: LVEF 40% for both sexes.
iii. Abnormal LV mass, relative to the body surface (BS)> 115 g / m2 in men and > 95 g / m2 in women.
iv. Severe abnormal LV mass / BS > 148 g / m2 in men and > 121 g / m2 in women.
v. The diastolic function of the LV was classified as normal or as stages I to IV based on the mitral flow profiles and tissue doppler image. Right ventricular systolic pressure (RVSP) was estimated from the tricuspid regurgitation rate using the modified Bernoulli equation [4].

To calculate the estimated glomerular filtration rate, the formula established by the CKD-EPI (Chronic Kidney Disease Epidemiology Collaboration) working group was used, which uses the parameters: age, sex, race, and serum creatinine value [5]. Hypertension was defined by a cut of 130/80 mm Hg, and alternatively as 140/90 mm Hg based on the eighth Joint National Committee (JNC-8) guidelines [6].

IX Design and Statistics

The study was analytical, observational, descriptive and retrospective. The echocardiogram was comparatively analyzed both before and after the transplant. A database was built whose information was tabulated and subsequently analyzed by the SPSS statistical program for statistical analysis. The results of the nominal variables were expressed in percentages and of the numerical variables on average standard deviation (SD) and confidence interval. Descriptive statistics were used, and the tables and graphs were made in the Microsoft Excel 2010 program.

Results and Analysis

Of the 132 adults undergoing kidney transplantation, 74 patients who met the inclusion criteria were identified, with an average age of 35.2 years with a standard deviation of 11.7 years, 48 (64%) male and 26 (36%) female. All patients were dependent on dialysis, with an average time of 5 years and 88% of the population underwent three times per week intermittent hemodialysis. (11.7). In the population of this study, in 43 (58.1%) patients the cause of renal failure was not determined, followed by 11 (14.9%) patients whose cause was glomerulopathy, leaving high blood pressure as the third most common cause with a total of 9 (12.2%) patients. With respect to comorbidities, 68 (91.9%) patients had high blood pressure (Table 1).

Over a period of approximately 6 months after transplantation, the average glomerular filtration rate estimated increased significantly from 5.9 to 76 mL/min/1.73m2 (<0.0001). Similarly, a significant decrease (<0,0001) in systolic blood pressure was shown with a systolic pre-transplant average of 134 mmHg to 110 mmHg post-transplant, with concomitant reduction in the number of antihypertensive treatment. The mean hemoglobin levels were 11.43 x 0.187, and 13.11 x 0.350 (<0.0001) before and after renal transplantation, respectively (Table 2).The systolic blood pressure in the pre-transplant period was high in 39 patients and normal in 35 patients and in the post-transplant period the 74 patients had normal SBP levels.

Table 2: Clinical and laboratory variables pre and post-transplant.

Variable	Pre transplant	Post transplant	Value p
eGFR CKD EPI (ml/min/1,73 m2)	5.9 ± 0.377	76 ±3.149	<0,0001
Blood pressure (mmHg)			
Systolic	134.39 ± 2.07	110.14±1.394	<0,0001
Diastolic	79.05 ± 1.366	70.54 ± 1.069	<0,0001
Hemoglobin (gr/dl)	11.43 ± 0.187	13.11 ± 0.350	<0,0001
Antihypertensive medication (Average No of Pills)	1.85 ± 0.101	1.28 ± 0.062	<0,0001

eGFR-CKD EPI: Estimated glomerular filtration rate using formula established by the Chronic Kidney Disease Epidemiology Collaboration working group; mmHg: millimeters of mercury grs/dl: grams/deciliter.

Table 3: Evolution of systolic blood pressure (SBP) before and after kidney transplantation.

Evaluation time	Number of patients with systolic blood pressure	Number of patients with normal systolic blood pressure levels
Pre-transplant	**39**	**35**
Post-transplant	**0**	**74**

This study observed a relationship between the years of dialysis with the thickness of LV, finding that 61 of the patients (84.7%) developed severe left ventricular hypertrophy with three or more years of dialysis. With regard to the echocardiogram, the LVDD, the LVSD, the posterior wall and the IVS decreased significantly when compared before and after the kidney transplant. By contrast, the dimensions of the left atrium decreased on average from 35.9 to 34.8 mm after renal transplantation, but this reduction was not statistically significant. Regarding systolic function of the left ventricle only one patient had slightly decreased ejection fraction prior to transplantation, the rest had a preserved systolic function, but when compared to the post-transplant echocardiogram, was found a statistically significant improvement (Table 4).

Table 4: Echocardiographic changes.

Echocardiographic measurements	Pre Transplant	Post Transplant	Value P
LVEF (%)	60.89 ± 1.175	66.81 ± 0.685	<0,0001
LV mass index (grs)	242.54 ± 11.92	184.62 ± 7.591	<0,0001
IA (mm)	35.9 ± 0.772	34.8±0.602	0,215
LVED (mm)	47.97 ± 0.756	44.98 ± 0.927	0,003
LVEDS (mm)	29.85 ± 0.897	26.68 ± 0.681	0,004
PW (mm)	11.86 ± 0.270	10.92 ± 0.208	0,002
IVS (mm)	12.12 ± 0.348	10.95 ± 0.253	0,002

Values are expressed in average-standard deviation. LVEF: Left ventricle ejection fraction; LVEDD: Diastole End Diameter LV; LVESD: End diameter of systole LV; PP: LV back wall; IVS: septum interventricular; LV: left ventricle.

Table 5: Modification of Post-transplant diastolic function.

Relaxation pattern	Pre transplant		Post Transplant	
	n	%	n	%
Normal	30	41%	48	65%
Type I Dysfunction	40	54%	25	34%
Type II Dysfunction	2	3%	1	1%
Type III Dysfunction	2	3%	0	0%

Table 5 shows the modification of the diastolic function of the left ventricle post-transplant. Before transplantation, 30 patients (41%) had a normal LV relaxation pattern and 44 (60%) had some degree of diastolic dysfunction, while after transplantation 48 patients (65%) had normal diastolic function and 26 (35%) had diastolic dysfunction.

Discussion

Chronic kidney disease (CKD) is a serious public health problem due to its high prevalence and high morbidity and mortality, with cardiovascular disease being the leading cause of death among chronic kidney patients [7]. In 2004 The National Heart Lung and Blood Institute introduces the term "cardiorenal syndrome," which is a state of advanced dysregulation between the heart and kidney, due to acute or chronic dysfunction. The alteration of one of them produce a vicious cycle that culminate in the deterioration of the other. [8-12].

Based on this concept, chronic kidney disease produces structural and functional changes of the heart such as left ventricle dilation, left ventricle systolic and diastolic dysfunction, and ventricular hypertrophy (LVH), the latter being the most commonly observed change in patients with CKD [13]. LVH is highly predictive of cardiovascular morbidity and mortality in addition to being very common among patients with chronic kidney disease. In this population the LVH is secondary to multiple factors such as high blood pressure, overload, the uremic environment, and the various inflammatory, metabolic and hormonal changes [14, 15].

Cardiovascular involvement is present in about 80% of patients on hemodialysis and 75% of patients who initiate dialysis have left ventricular hypertrophy (LVH) [16, 17]. This study found that 84.7% of patients who developed severe left ventricular hypertrophy had three or more years of dialysis [18].

Kidney transplantation has made great advances in recent years, becoming the treatment of choice for those patients with chronic end-stage kidney disease, significantly improving the quality of life and life expectancy of these, compared to permanent renal replacement therapy [19]. Renal transplantation results in a suitable glomerular filtration rate, which corrects the volume and decreases uremic toxins. Successful kidney transplantation has been shown to be associated with significant improvements in the LVMI, ventricular function and valvular regurgitation post-renal transplantation. This structural and functional inverse remodeling of the heart plays a critical role in cardiovascular mortality. Thus, a 10% decrease in left ventricular mass results in a 28% reduction in the risk of cardiovascular mortality [20].

In accordance with previous studies, this work demonstrates that restoring kidney function through transplantation improves blood pressure and significantly decreases left ventricular hypertrophy [21-25]. In addition, there is evidence that a successful renal transplant significantly decreases the use of antihypertensive medication, indicating that better pharmacological control of hypertension was not an independent factor contributing to the reduction of LVH. Pre-transplant systolic blood pressure levels and post-transplant decreased blood pressure appear to be critical for a reduction in the left ventricle mass.

In the literature, the prevalence of left ventricle (LV) systolic dysfunction varies between 15% in patients initiating hemodialysis treatment and 18% for those with regular dialytic treatment and may reach 28% in those evaluated for transplant [26]. In this research, most patients had preserved left ventricle systolic function and is concordant with data from other studies that after transplantation the ejection fraction improved significantly. Diastolic dysfunction is common in chronic kidney patients and is related to LVH and cardiac fibrosis [27]. Similarly, diastolic function has also been shown to improve after transplant [28, 29]. This data was replicated in this paper, as more than half of left ventricle chronic end stage renal failure patients had some degree of diastolic dysfunction prior to transplantation, while after transplantation 65% of the population achieved normal diastolic function.

One of the limitations of this study is its retrospective nature, which did not allow controlling the time of echocardiograms and inter-operator variability. On the other hand, the study comprises a population of chronic end-stage renal patients with a low prevalence of cardiovascular disease and did not evaluate neither the symptoms and functional status of patients, nor metabolic, inflammatory or hormonal parameters.

Conclusion

This study shows a favorable overall impact of renal transplantation on the structure and function of the heart, with a significant reduction in left ventricular hypertrophy, improvement in left ventricular systolic and diastolic function, thereby reducing the risk of death associated with cardiovascular events. In addition, it was shown that in renal transplant patients, the improvement in systolic blood pressure is an important prognostic factor for positive changes observed in the heart following kidney transplantation.

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Conflicts of Interest

None.

Ethical Responsibilities

Protection of people and animals. The authors state that no experiments have been conducted on humans or animals for this research.

Confidentiality of Data

The authors state that no patient data appears in this article. Right to privacy and informed consent. The authors state that this article does not show patient data.

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