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Structural and Functional Changes in the Heart in Patients with Chronic Kidney Disease on Hemodialysis

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Abstract

Background: There is a higher risk of cardiovascular mortality in patients with chronic kidney disease (CKD) than in the general population. Structural and functional alterations in the heart are said to be the major causes of mortality in dialysis patients. *Objectives:* This study was designed to examine the structural and functional changes in the heart in patients undergoing hemodialysis. *Methods:* This was retrospective study done by chart review. Details of echocardiographic parameters of twenty patients at the initiation and after one year of hemodialysis treatment were collected and compared. *Results:* There were differences in the weight (64 ± 12 Vs 57 ± 12 kg, $p < 0.001$), left atrial size (35 ± 1 Vs 35 ± 1 mg/dl, $p = 0.210$), LVIDS (26 ± 4 Vs 26 ± 5 mm, $p = 0.413$), LVIDD (46 ± 3 Vs 45 ± 5 mm, $p = 0.082$), IVS (12 ± 3 Vs 13 ± 3 mm, $p < 0.001$), LVPW (11 ± 1 Vs 12 ± 1 mm, $p = 0.016$), left ventricular mass (202 ± 64 Vs 205 ± 59 mg, $p = 0.001$), left ventricular mass index (120 ± 30 Vs 134 ± 37 gm/m², $p = 0.023$) and ejection fraction (61 ± 24 Vs $58 \pm 59\%$, $p = 0.045$). The frequency of diastolic dysfunction increased over a period of one year. There was also a significant reduction in the mean ejection fraction at the end of one year after dialysis. *Conclusions:* This study concludes that, in patients on hemodialysis, there are significant structural and functional changes in the heart, in the form of increase in left ventricular mass, increase in the prevalence of left ventricular hypertrophy and also reduction in systolic and diastolic functions.

Keywords: CKD; CVD; Left Ventricular Hypertrophy; India.

Introduction

It has been known for several years that chronic kidney disease (CKD) is associated with very high mortality and accelerated cardiovascular disease. Structural heart disease is an inevitable consequence of CKD and is an important predisposing factor for sudden cardiac death [2]. Left ventricular hypertrophy (LVH), the most common structural complication is the single most important cause for sudden cardiac death [3]. Indians, an ethnic group which has high risk for cardiovascular mortality also have a high risk of left ventricular hypertrophy [4].

However, there are a few published studies from India examining at the changes in left ventricular mass and cardiac function in patients on hemodialysis. Hence this study was done to examine the changes in left ventricular hypertrophy, systolic and diastolic functions of the heart in patients initiated on hemodialysis.

Methods

This study was a retrospective study by chart review and was approved by the scientific and ethical

committee of Amrita Institute of Medical Sciences, Kochi. Duration of follow up was one year. Patients undergoing hemodialysis at Amrita Institute of Medical Sciences, Kochi who had undergone echocardiography prior to initiation of hemodialysis and consented for the study. After obtaining an informed consent, patients were enrolled in the study. The details of required parameters were collected from medical records. All patients had undergone two dimensional M mode & Doppler echocardiography performed on Siemens acuson CV70, in left lateral decubitus position using 3.5 MHz transducer by consultant cardiologist at AIMS, experienced in echocardiography. Left ventricular Mass was calculated by the following cube formula after measuring left ventricular posterior wall thickness at end diastole (PWd) & interventricular septal wall thickness at end-diastole:

$$LVM = 0.8 \times [1.04 \times (LVEDD + PWd + IVSd)^3 - LVEDD^3] + 0.6.$$

Calculation was done using the online calculator (Cardio math) of Canadian Society of Echocardiography. LVMI was calculated using the same calculator by indexing with body surface area.

Left ventricular hypertrophy was defined as LVMI \geq 95g/m² in females and \geq 115g/m² in males [5].

SPSS version 15 was used for data analysis. Paired sample t- test was used to compare the mean values of the clinical, biochemical and echocardiographic parameters before and one year after dialysis. McNemar's test was used to compare the frequencies

of LVH before and after dialysis p value less than 0.05 was considered significant. Data of 20 patients were considered for final analysis.

Results

The study group comprised of total 20 patients, in which there were 12 male patients and 8 female patients. Mean age was 64 + 11 years, with a range of 30-80 years. There were 13 diabetic patients (65%) in the study. In the total 20 patients 8 patients (40%) had coronary artery disease before the initiation of hemodialysis and 13 patients (65%) had coronary artery disease after 1 year (Figure 1). 5 new cases developed coronary artery disease within 1year. There were differences in the weight (64 ±12 Vs 57±12 kg, p= <0.001),left atrial size (35±1 Vs 35±1mg/dl, p=0.210),LVIDS (26±4 Vs 26±5mm, p=0.413),LVIDD (46±3 Vs 45±5mm, p+=0.082),IVS (12±3 Vs 13±3mm, p=<0.001),LVPW (11±1 Vs 12±1mm, p=0.016),left ventricular mass (202±64 Vs 205±59mg, p=0.001),left ventricular mass index (120±30 Vs 134±37gm/m², p=0.023) and ejection fraction (61±2.4 Vs 58±5.9%, p=0.045) one year after initiation of hemodialysis (Table 1).

The frequency of diastolic dysfunction before hemodialysis was as follows: Grade III-0%, Grade II-15%, Grade I-70%, and no diastolic dysfunction - 15%. The frequency of diastolic dysfunction after one year was Grade III-5%, Grade II-30% Grade I-60%

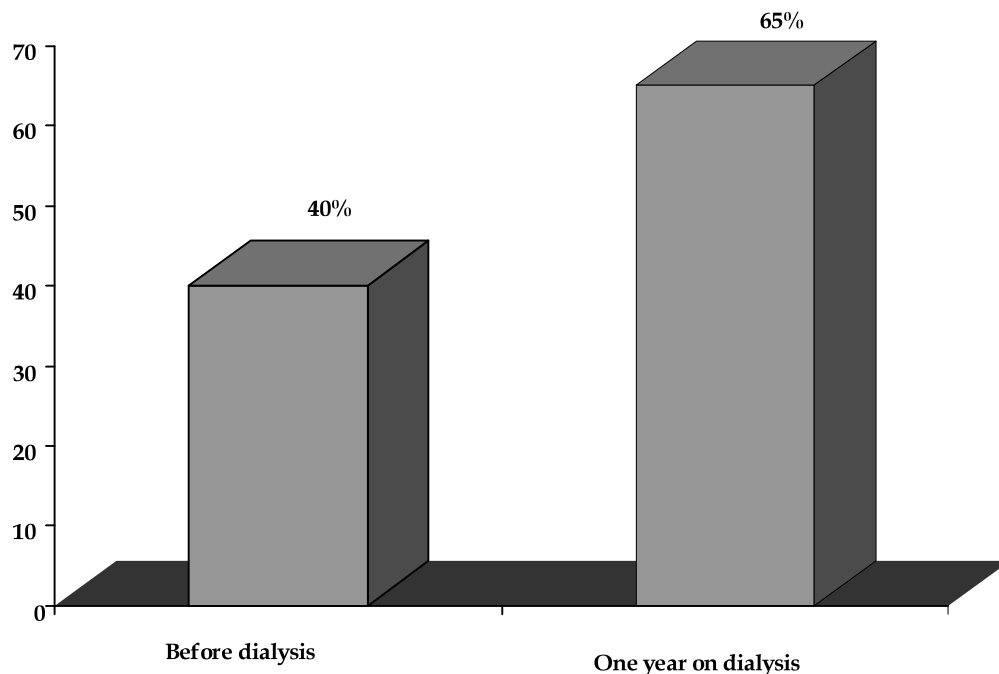


Fig. 1: Coronary artery disease in patients before and one year after initiation of hemodialysis

Table 1: Echocardiographic parameters before and one year after dialysis

Parameter	Before hemodialysis	One year on hemodialysis	p value
LA (mm)	35 ± 1	35 ± 1	0.210
LVIDS (mm)	26 ± 4	26 ± 5	0.413
LVIDD (mm)	46 ± 3	45 ± 5	0.082
IVS (mm)	12 ± 3	13 ± 3	<0.001
LVPW (mm)	11 ± 1	12 ± 1	0.020
LV Mass (gm)	202 ± 64	205 ± 59	0.001
LV Mass Index (gm/m ²)	120 ± 30	134 ± 37	0.023
Ejection Fraction (%)	61 ± 2.4	58 ± 5.9	0.045

Table 2: Frequency of diastolic dysfunction before initiation and one year after dialysis

GRADE	Before dialysis	One year on dialysis
No	3 (15%)	1 (5%)
Grade I	14 (70%)	12 (60%)
Grade II	3 (15%)	6 (30%)
Grade III	0 (0%)	1 (5%)

and no diastolic dysfunction-5% (Table 2).

Discussion

Several studies have reported a prevalence of LVH between 60-90 % amongst patients on dialysis [6,7]. A study from Delhi showed a prevalence of 96% in patients with severe CKD⁸. Another study from Pune showed a prevalence of 74.3% [9]. A recent study done in Kolkata reported a prevalence of 87% in patients with severe CKD [10]. Our study showed a prevalence of 70% at the beginning of dialysis.

One of the most critical periods in the life of a patient with CKD is the start of dialysis [11]. Especially the first 90-120 days are associated with an increased risk of mortality¹². We also noticed significant increase in the number of coronary events during the first year after initiation of dialysis. Over a period of one year, the prevalence of LVH increased to 85% in this study. A recent study in elderly patients showed a high incidence of stroke following the start of dialysis with a peak in the first month of dialysis. The risk of stroke was increased by the presence of the hypertension, atherosclerotic disease and diabetes. None of the patients in the study group developed stroke in the one year following initiation of dialysis.

There was a significant increase in the left ventricular mass (202±64 Vs 205±59mg, p=0.001), left ventricular mass index (120±30 Vs 134±37gm/m², p=0.023) and ejection fraction (61±2.4 Vs 58±5.9%, p=0.045) over a period of one year. LVH, which develop as adaptive response in the early stages may eventually lead to functional impairment including

reduced compliance of the left ventricular wall during diastole (diastolic dysfunction) and impaired myocardial contractility (Systolic dysfunction) or both. At the start of dialysis, 85% of our patients have some degree of diastolic dysfunction. Moreover, the prevalence increased to 95% at the end of one year. Moreover, the degree of diastolic dysfunction also worsened in patients over a period of one year.

Systolic dysfunction in terms of ejection fraction also increased significantly in the course of one year. The mean EF was 61% at the beginning of dialysis which decreased to 58% at the end of one year. Hence our study also suggests there is a significant structural and functional worsening of cardiac function over a period of time in patients on hemodialysis.

This study concludes that, in patients on hemodialysis, there are significant structural and functional changes in the heart, in the form of increase in left ventricular mass, increase in the prevalence of left ventricular hypertrophy and also reduction in systolic and diastolic functions.

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