Journal of Cardiovascular Diseases & Diagnosis

Shivendra et al., J Cardiovasc Dis Diagn 2014, 2:4
DOI: 10.4172/2329-9517.1000165

Research Article Open Access

Echocardiographic Changes in Patients with ESRD on Maintenance Hemodialysis-A Single Centre Study

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Received date: May 29, 2014, **Accepted date:** June 7, 2014, **Published date:** June 14, 2014

Abstract

Objective: To evaluate and analyze the echocardiographic changes in end stage renal disease patients on maintenance hemodialysis.

Material and methods: End stage renal disease (ESRD) patients on maintenance hemodialysis for at least 3 months were included in the study. We performed M-mode echocardiography in 35 ESRD patients during inter-dialytic period usually after 18 hours, without obvious clinical evidence of coronary artery disease, valvular heart disease, congenital heart disease and pericardial effusion.

Results: Echocardiography revealed LV dilation and diastolic dysfunction in 18 (51.2%), left ventricular hypertrophy (LVH) in 17 (48%), systolic dysfunction and pericardial effusion in 10 (28.57%) and 6 (17.14%) patients respectively. RWMA was present in 8.5% and valvular calcification was not seen in our patient group. In sub-group of patients with Hb<10 gm%, LVH was present in 71.42% (15) vs 14.28% (2) in patient group with Hb ≥ 10 gm% (p=0.002). Hypertensive patient population also had higher prevalence of LVH (51.85%)] and systolic dysfunction and RWMA was absent in normotensive group.

Conclusion: LV diastolic dysfunction and hypertrophy were most common echocardiographic findings. There was statistically significant correlation between anemia and presence of LVH and positive correlation between presence of hypertension and LVH.

Keywords: ESRD; Echocardiography; MHD; LVH; Diastolic dysfunction

Introduction

Chronic Kidney Disease (CKD) is a major public health problem worldwide with increase in incidence and prevalence. Diabetes (DM) and hypertension (Htn) are the leading cause of CKD worldwide, whereas hypertension is a cause as well as effects of CKD. Recently genetic background of hypertension is gaining importance in pathophysiology of hypertension. G protein coupled and Ca^{2+} dependent kinases are responsible for control of blood pressure [1]. Even lots of mutation may cause changes in the receptors, which in turn raise blood pressure [2]. CKD is risk factor for cardiovascular event and complications increases as CKD progress to end stage renal disease (ESRD) [3]. Cardiovascular (CV) mortality is 10-20 times more common in ESRD patients on renal replacement therapy as compared to general population. One of the major structural cardiac anomalies in patients with CKD is left ventricular hypertrophy (LVH) and is associated with increase the risk for cardiac ischemia, congestive heart failure, as well as a very strong independent predictor of cardiovascular mortality [4]. Majority patients with CKD die due to cardiovascular events before reaching ESRD due to both traditional and nontraditional risk factors [5]. Whether CV events differ in patients with and without CKD is poorly defined and also whether differences in cardiovascular disease in CKD patients suggest preventive or therapeutic strategies unique to this population is unclear.

Anemia and hypertension are most consistently associated with cardiac failure, a pre-lethal occurrence that predated two thirds of all dialysis patients' death [6]. ESRD patients do have myriads of structural and functional cardiac abnormalities which includes LVH, depressed LV function, regional wall motion abnormality, pericardial effusion and valvular calcification.

Hemodialysis is one form of renal replacement therapy, during which metabolic waste products including creatinine, urea, excess water and salt are removed. It also maintained the nutritional status, mental and physical wellbeing if done on regular basis. Noor ul Amin et al had shown that hemodialysis is an effective means of removing metabolic waste products [7].

In this study we evaluated the cardiovascular abnormalities by performing 2-D echocardiography in CKD patients on maintenance hemodialysis (MHD).

Material and Methods

Thirty five (35) ESRD patients irrespective of underlying etiology were included in this study. A person was labeled as ESRD if his or her GFR was less than 15 ml/1.7 m^2 as per Modified Diet in Renal Disease

(MDRD) formula and who were on MHD. Patient with obvious clinical evidence of coronary artery disease, valvular heart disease and pericardial effusion, rheumatic heart disease, congenital heart disease and primary cardiomyopathies were excluded from the study. All patients were clinically evaluated thoroughly and subjected for complete blood count, renal function test, serum cholesterol, calcium, and phosphate and 2-D echocardiography. 2D-Echocardiography machine GE LOGIQ 400 PRO was used with 3.5 MHz transducer probe. The M. mode recording perpendicular to the long axis of and through the centre of the left ventricle at the papillary muscle level was taken as standard measurements of the systolic and diastolic wall thickness and chamber dimensions. The left ventricular ejection fraction (LVEF) and fractional shortening (FS) were taken as measure of left ventricular systolic dysfunction and ejection fraction<55% was considered as systolic dysfunction. Diastolic function was determined by measuring E/A ratio by special Doppler inflow velocity (E is peak early diastole velocity and A is peak atrial filling velocity of left ventricle across mitral valve). E/A ratio less than 0.75 and more than 1.8 was considered as diastolic dysfunction. LVH was diagnosed when interventricular septum thickness or left ventricular posterior wall thickness was ≥ 12 mm. Hypertension was defined as BP ≥ 140/90 mmHg in right arm supine position and anemia was diagnosed with hemoglobin<13.5 gm/dl in male and 12.5 gm/dl in female.

Statistical analysis

This was done by SPSS software version 15 by using chi square test. A 'p'value less than 0.05 were considered significant.

Results

This study included 35 patients of ESRD on MHD. Clinical examination, suggested laboratory test and echocardiography were performed in every patient.

Figure 1: Sex distribution of study patients

Out of 35 patients, 77% male and 23% were female. Maximum patients were in age group between 41-50 yrs (34%) (Figure 1)

Mean age of the patients was 45.5 ± 23.5 (Figure 2).

Figure 2: Bar diagram showing age distribution of patients

Basic demographic and clinical characteristic were shown in Table 1. Hypertension was present in 27 (77.14%) mainly in age group more than 40 years.

Parameters	Range	Mean ± SD
Age (Years)	21-70	47.57 ± 12.57
Calcium (mg/dl)	05.3-11.4	08.72 ± 1.16
Phosphorus (mg/dl)	04.3-13.9	07.12 ± 2.26
Urea (mg/dl)	76.00-300.6	150.62 ± 55.75
Creatinine (mg/dl)	03.9-14.2	8.13 ± 2.27
Hemoglobin % (gm/dl)	05.6-12.00	09.15 ± 1.58
Serum albumin (gm/dl)	02.6-04.8	03.31 ± 0.49
Total cholesterol (mg/dl)	150-300.1	195.11 ± 38.83

Table 1: Basic demographic profile and laboratory parameters of study population

Most common cause of ESRD was diabetes 15 (42%), followed by hypertension, chronic glomerulonephritis (CGN) and chronic tubulointerstitial nephritis (CTIN) in 10 (28%), 5 (14%) and 3 (8.5%) cases respectively (Figure 3).

Figure 3: Bar diagram showing basic disease of the study population

Anemia was observed in all patients and hemoglobin of less than 10 gm% was seen in 21 (60%) patient.

Echocardiographic findings were studied and analyzed in details. Echocardiographic parameter analyzed in our study were left ventricular internal diameter in diastole (LVIDd), left ventricular internal diameter in systole (LVIDs), Interventricular septal diameter in systole, E/A ratio, fractional shortening, ejection fraction and size of left atrium (Table 2).

Mean echocardiography parameters in cases of ESRD on MHD	No of cases	%
Left ventricular hypertrophy	17	48.00%
Ejection fraction (<55%)/Systolic dysfunction	10	28.57%
E/A ratio (<0.75 or >1.8)/Diastolic dysfunction	18	51.42%
Regional wall motion abnormality	3	8.50%
Pericardial effusion (<10 mm)	6	17.14%
Valvular calcification	0	0

Table 2: Echocardiographic parameters in ESRD patients on MHD

On comparing the echocardiographic findings in patients with Hb <10 gm% vs patients with Hb ≥ 10 gm%, statistically significant number of patients had LVH; 71.42% vs 14.28% (Table 3).

Echocardiographic Findings	Hb level				P-value
	<10 gm/dl		≥ 10 gm/dl		
	N (21)	% (60)	N (14)	% (40)	
LVH					
Absent	6	28.57	12	85.71	0.02

Present	15	71.42	2	14.28	
Decreased EF (<55%)					
Absent	14	66.66	11	78.57	0.07
Present	7	33.33	3	21.42	
RWMA					
Absent	18	85.71	14	100	0.26
Present	3	14.28	-	-	
Pericardial Effusion					
Absent	17	80.95	12	85.71	1.00
Present	4	18.18	2	14.28	

Table 3: Hemoglobin level and echocardiographic parameters of study patients

Similarly majority patients with LVH had hypertension (51.85%) compared to normotensives (8.58%), although it was not statistically significant (Table 4). RWMA was present in 14.28% patients with hemoglobin of <10 gm%, but absent in patients with Hb ≥ 10 gm% and in normotensive group.

Echocardiographic Findings	Hypertension				P-value
	< 140/90 mmHg		≥ 140/90 mmHg		
	N (08)	% (22.85)	N (27)	% (77.14)	
LVH					
Absent	5	62.5	13	48.14	0.38
Present	3	37.5	14	51.85	
Decreased EF (<55%)					
Absent	5	62.5	16	59.25	0.08
Present	3	37.5	11	40.47	
RWMA					
Absent	8	100	24	88.88	0.46
Present			3	11.11	
Pericardial Effusion					
Absent	7	87.5	22	81.48	0.58
Present	1	12.5	5	18.51	

Table 4: Association between HTN with LV dysfunction of study patients

Discussion

Cardiovascular disease is the major cause of death in patients with end stage renal disease. The detection of echocardiographic abnormalities with subclinical cardiac disease is considered to be an important step for characterization of individual risk for heart failure in the general population as well as in patients of ESRD [5] .The common cardiac abnormalities in CKD patients are LVH, systolic and diastolic dysfunction due to myocardial fibrosis, myocardial calcification and changes in the vascular structure, leading to adverse cardiovascular events.

In our study LVH was present in 48%, systolic dysfunction in 28% and diastolic dysfunction in 51.42% of patients. Echocardiographic findings in other studies have also observed presence of systolic dysfunction in 20% and diastolic dysfunction in 50% patients [8,9]. Agarwal S. et al. had observed diastolic dysfunction in 53.2% and systolic dysfunction in 30% patients with severe CKD (S. Cr. >6 mg %) [10]. We observed pericardial effusion and RWMA in 17.14% and 8.5% cases respectively. In a study conducted by Laddha M et al. in 2014, reported LVH in 74%, systolic dysfunction in 24.3%, diastolic dysfunction in 61.4% and pericardial effusion in 14.35% of ESRD patients on hemodialysis [11]. Zoccali C et al. had reported incidence of LVH and systolic dysfunction of 77% and 22% respectively in ESRD population on hemodialysis [12]. Valvular calcifications are four times more common in dialysis patients compared to general population [13]. None of our patients had valvular calcification probably because of small study population.

Majority (77.14%) patients had hypertension. In hypertensive group LVH was present in 51% vs 8.57% in normotensive group. In sub-group of patients with hemoglobin level <10 gm%, LVH was seen in 71.42% compared to 14.28% in patients with hemoglobin of ≥ 10 gm% (p=0.002). Patrick et al. had showed that rise in mean arterial pressure was associated with increased incidence of LVH in ESRD population on hemodialysis [14]. Levin et al also reported association between elevated systolic blood pressure and low hemoglobin level with LVH in predialysis patients [15,16]. Anemia is a strong predictor of development of LVH and mortality and morbidity in ESRD [6]. Datta et al observed severity of anemia correlated to LVH in patients with CKD [17]. In ESRD patients on dialysis it has been observed that decrease in Hb level of 1 gm% increased LVH by ≈ 50% and mortality by 18-25% [18].

Conclusion

Cardiac structural as well as functional abnormalities are common in patients with ESRD, more so in those with hypertension and anemia. LVH is the commonest cardiac abnormality in ESRD patients, followed by diastolic dysfunction. Both conditions are more marked in hypertensive and anemic populations. LVH has got prognostic implications, because this group of ESRD patients will die of diastolic dysfunction or sudden cardiac death [19]. Echocardiography is a cost effective noninvasive diagnostic test which can detect early changes in the cardiac parameters. This is important for risk stratification and early preventive measures. Thus echocardiographic screening of ESRD patients has both therapeutic and prognostic implications. All asymptomatic ESRD patients especially anemic and hypertensive should undergo a routine echocardiographic evaluation.

Drawback

Limitations of our study:

1. Small number of patients.
2. Impact of hyperlipidemia, secondary hyperparathyroidism, homocysteine levels, and markers of inflammation and duration of MHD were not studied in our patient population.

3. Lack of follow up

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