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Original Research Article

Evaluation of echocardiographic variables in patients of chronic renal failure: pre and post hemodialysis-a single center prospective study

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ABSTRACT

Background: Cardiovascular disease is the leading cause of morbidity and mortality at each stage of Chronic Kidney Disease (CKD) around 30%-45% of patients of stage 5 CKD have advanced cardiovascular complications. Congestive Heart Failure is responsible for approximately 15% death in hemodialysis patients. Hence this study was done with the aim to evaluate the effects of Hemodialysis on various Cardiac parameters detected by 2D Echocardiography in patients with Chronic Kidney Disease.
Methods: In this prospective cohort study, 54 patients with Stage 4 and 5 CKD were evaluated for various cardiac parameters by 2D Echocardiography before and after Hemodialysis and detailed characteristics of the patients were analyzed using SPSS version 16 and paired student t-test.
Results: Among 54 patients with CKD, 9% (5/54) patients had stage 4 CKD while 91% (49/54) had stage 5 CKD. Hypertension was present in 81.48% (44/54) of patients and Left ventricular hypertrophy was present in 77.77% (42/54). 6 (11%) patients had associated pericardial effusion. Mean Pre and Post Hemodialysis Left ventricular end diastolic diameter (LVIDed) and Left ventricular end systolic diameter (LVIDes) was 50.38±4.16mm and 48.91±4.14mm; 33.54±3.29 mm and 32.58±2.80 mm respectively which was statistically significant (p <0.001). Pre-HD Left atrial diameter was 34.20±3.81mm and it became 33.19±3.30mm Post-HD (p <0.001). Left ventricular mass index (LVMI) was 136.70±35.91 g/m2 pre-HD and 125.54±29.35 g/m2 post-HD which is significant. Left Ventricular Ejection Fraction was 47.34±5.72% before HD and it became 48.82±4.56% after 6 session of Hemodialysis over 3 weeks which is statistically significant (p<0.038).
Conclusions: The present findings suggest patients with Stage 4 and 5 CKD who were on hemodialysis there was significant improvement in various cardiac parameters apart from increase in left ventricular ejection fraction, which may lead to decrease morbidity and mortality in these patients.

Keywords: Chronic kidney disease, Hemodialysis, Left ventricular mass index, Left ventricular ejection fraction

INTRODUCTION

Chronic kidney disease (CKD) is a worldwide public health problem, both for the number of patients and cost of treatment involved. Cardiovascular disease is the leading cause of morbidity and mortality at each stage of Chronic Kidney Disease (CKD). 30%-45% of patients of stage 5 CKD have advanced cardiovascular complications.[1] In patients who are on hemodialysis Congestive Heart Failure is responsible for approximately 15% deaths and substantial non-fatal dialysis associated morbidity.[2] This is an underestimate as patients with

CKD are more likely to die of cardiovascular disease (CVD) than to reach end-stage renal disease (ESRD).

Renal disease proved to be associated with early and subclinical impairment of LV systolic function.[3] Left ventricular hypertrophy and dilated cardiomyopathy related primarily to prolonged hypertension and extra cellular fluid overload, in addition to anemia and iatrogenic AV fistula leads to heart failue.[4] Hemodialysis cause decrease in blood volume and ventricular filling pressure which consequently leads to decrease left atrial diameter and left ventricular filling pressure however cardiac index did not decrease significantly.[5] Cardiovascular morbidity in CKD patients on hemodialysis have been poorly characterized. So, study aim was to assess the effects of hemodialysis on various cardiovascular complications in patients with stage 4 or 5 chronic kidney disease.

METHODS

This study was conducted on patients of CKD who attended/admitted in OPD/IPD at the department of medicine, S.B.V.P. Hospital, associated with LLRM Medical College, Meerut (U.P.), over a period of 18 months (April 2017-september 2018), after approval from the Institutional Ethics Committee. The study cohort consisted of patients with age >18 years who had given written consent and fulfilled KIDGO criteria of CKD.[2] The patients who do not give written informed consent, have already undergone hemodialysis, had Arterio Venous fistula, any substance abuse, mental illness, had history of coronary artery disease and other cardiac disorders such as valvular heart disease, congenital heart disease were excluded from study. A Total number of 54 patients with stage 4 and 5 were included in the final analysis.

Eligible patients were examined clinically and evaluated with haemogram, blood urea, serum creatinine, urine R/M, Urinary albumin creatinine ratio (UCAR), 24 hour urinary protein, electrocardiography (12 lead standard), chest X-ray PA view, ultrasound abdomen, 2D echocardiography: M-mode and pulsed Doppler transthoracic echocardiography at baseline. Patients with CRF stage 4 and 5 started on maintenance hemodialysis for the first time. All (hemodialysis naive CKD stage 4 and 5 patients), patients received twice weekly bicarbonate based hemodialysis for 3 weeks and each session lasting for 3.5 to 4 hours using polysulfone and bicarbonate dialysate containing 140mmol per litre of sodium, 3.0mmol per litre of potassium, 2.5meq per litre calcium. Hemodialysis sessions were uncomplicated for all patients. Patient's intravascular volume status was controlled with ultrafiltration during dialysis, diuretics and dietary salt and water restriction. All patients received treatment for associated comorbidities like anaemia, phosphate binders, iron, calcium, calcitriol, inj. erythropoietin.

2D Echocardiography had been done in these patients after 6 sessions of hemodialysis and following M Mode parameters were measured -

- Left ventricular end diastolic diameter (LVIDed)
- Left ventricular end systolic diameter (LVIDes)
- Ventricular septum thickness (IVSTed)
- Posterior wall thickness in diastole (PWTed)
- Left atrial diameter

The following parameters were calculated:

Left ventricular mass (LVM): calculated by ASE formula i.e.

$$LVM=0.8[1.04\{(LVIDed+PWTed+IVSTed)^3-(LVIDed)^3\}]+0.6 \text{ gm}$$

Left ventricular mass index (LVMI): LVM indexed to body surface area (BSA) g/m^2.

Ejection fraction: Left ventricular overall ejection fraction (systolic function) was calculated by modified Simpson's method.

Left ventricular fractional shortening: fractional shortening was calculated as

$$FS\ (\%) = (LVDd-LVDs)/LVDd \times 100$$

Statistical analysis

Statistical analysis was done using SPSS version 16 for windows software. Data consisting of continuous variables were reported as Mean±Standard deviation. A paired Student's t-test was employed to assess the significance of differences between measurements obtained pre and post hemodialysis. P- value <0.05 is considered as significant.

RESULTS

The total number of 113 patients with stage 4 and 5 were enrolled for the study, but among them 43 patients were lost to follow-up and 16 patients did not complied as per the planned schedule of the hemodialysis sessions and thus excluded. Hence the final study cohort comprised of 54 patients. The mean age of the patients was 49.37±12.23 years. Out of 54 patients 67% (36/54) were males and 33% (18/54) were females. Around 9% (5/54) patients had stage 4 CKD while 91% (49/54) had stage 5 CKD. Hypertension is present in 81.48% (44/54) of patients and Left ventricular hypertrophy was present in 77.77% (42/54). 6 (11%) patients had associated pericardial effusion. Baseline characteristics of all patients were measured and are shown in Table 1.

Pre and post hemodialysis, (after 6 session of hemodialysis over 3 weeks) echocardiographic parameters were compared and p- value was calculated as

shown in Table 2. Mean Pre HD Left ventricular end diastolic diameter (LVIDed) was 50.38±4.16mm while post HD it was 48.91±4.14mm which was statistically significant (p<0.0001) (Table 2).

Table 1: Baseline Characteristics of study population.

Parameters (n=54)	Mean± SD
Age(yrs)	49.37±12.23
Systolic BP (mmHg)	158±25.9
Diastolic BP (mmHg)	96±13
Blood Urea(mg/dl)	184±51
Serum Creatinine(mg/dl)	7.45±2.56
eGFR	9.59±3.71

Pre-HD Left ventricular end systolic diameter (LVIDes) was 33.54±3.29 mm while Post-HD it was 32.58±2.80 mm with p<0.001 i.e., statistically significant (Table 2). Ventricular septum thickness (IVSTed) Pre-HD was 10.68±1.35mm and Post-HD it was 10.42±1.56 mm, which was not found to be statistically significant (p>0.05) (Table 2). Posterior wall thickness in diastole (PWTed) was 11.12±1.64mm Pre-HD and 10.40±1.18 mm Post-HD and the difference is statistically significant (p <0.001) (Table 2). Pre-HD Left atrial diameter was 34.20±3.81mm and it became 33.19±3.30mm Post-HD and found to be statistically significant (p <0.001) (Table 2). Left ventricular mass index (LVMI) was 136.70±35.91g/m2 Pre-HD and 125.54±29.35g/m2 Post-HD which is significant (p<0.001) (Table 2).

Table 2: Echocardiographic parameters–pre and post hemodialysis.

2D ECHO parameters (N=54)	Pre-hemodialysis	Post-hemodialysis	P-value
Left ventricular end diastolic diameter (LVIDED) (MM)	50.38±4.16	48.91±4.14	<0.0001
Left ventricular end systolic diameter (LVIDES) (MM)	33.54±3.29	32.58±2.80	<0.001
Ventricular septum thickness (IVSTED) (MM)	10.68±1.35	10.42±1.56	0.260
Posterior wall thickness in diastole (PWTED) (MM)	11.12±1.64	10.40±1.18	<0.001
Left atrial diameter (MM)	34.20±3.81	33.19±3.30	<0.001
Left ventricular mass (LVM)(G)	206.57±49.97	189.76±44.04	<0.001
Left ventricular mass index (LVMI) (G/M²)	136.70±35.91	125.54±29.35	<0.001
Left ventricular fractional shortening (%)	34.06±3.95	34.11±4.41	0.842
Left ventricular ejection fraction (EF) (%)	47.34±5.72	48.82±4.56	0.039

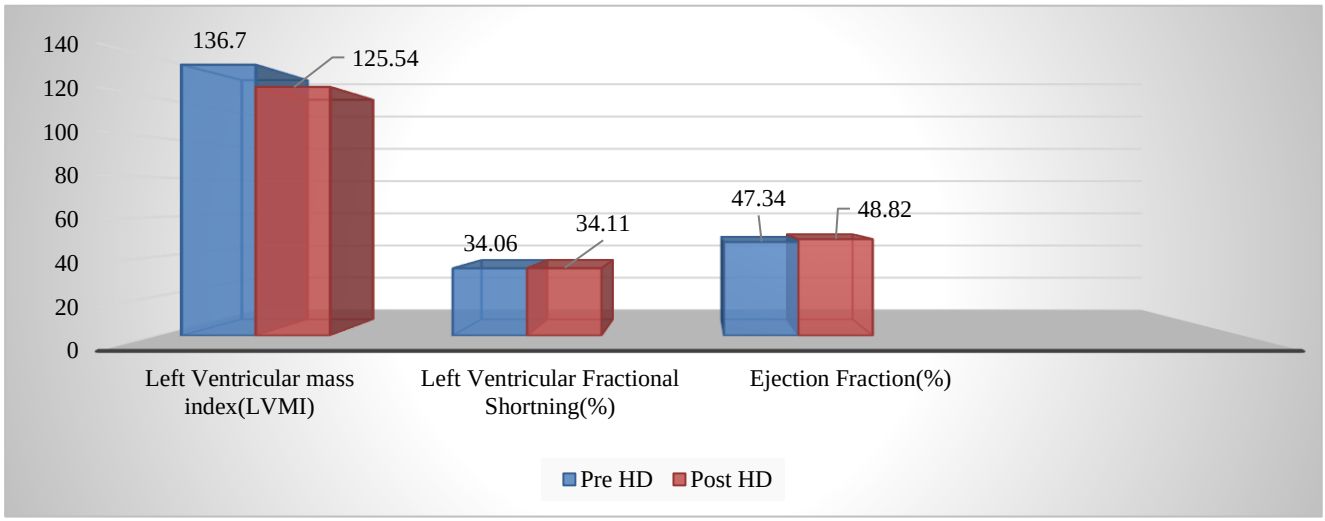

Figure 1: Changes in LVMI, LVFS and LVEF-pre and post hemodialysis.

DISCUSSION

In our study which included 54 patients having mean age of 49.37±12.23 years and majority of patients (81%) had hypertension. Out of these patients (n=54): 9% & 91% patients were having stage 4 CKD and stage 5 CKD respectively. In our study LVH was present in 78 % of patients and severity of LVH is more in end stage renal disease patients. LVH is highly prevalent in CKD and is associated with a clearly unfavorable prognosis. More than 2/3rd of patients undergoing hemodialysis with LVH die of CHF or sudden death.[6] Incidence of LVH increases with progressive decline in renal function, with in inverse linear correlation between LV mass and GFR.[7]

In our study left ventricular systolic dysfunction was seen in 16% of all patients and diastolic dysfunction was seen in 23% of all patients. In one study Aggarwal et al had observed diastolic dysfunction in 53.2 % and systolic dysfunction in 30 % of patients in severe CKD.[8] In a study conducted by Laddha M et al in 2014 reported that LVH in 74 %, systolic dysfunction in 24.3%, diastolic dysfunction in 61.4% and pericardial effusion in 14.35% of end stage renal disease patient on hemodialysis.[9] A study done by Zoccali S et al had reported incidence of LVH and systolic dysfunction of 77% and 22% respectively in end stage renal disease patient.[10]

Our study showed that LV end diastolic diameter (LVIDed) and LV end-systolic diameter (LVIDes) decreased significantly following three weeks of maintenance hemodialysis (after 6 sessions of hemodialysis). Our results were similar with the findings of other studies which shows that LV end diastolic volume and end systolic size significantly decrease along with decrease in left ventricular mass index after hemodialysis.[11,12]

Our study showed that interventricular septal thickness (end diastolic) decreased after six sessions of hemodialysis however it was not statistically significant.

Left ventricular ejection fraction (EF) also improved significantly in our study population following hemodialysis sessions protocol. Similarly, a study done by Mark AB et al in 2011 also showed that a single session of hemodialysis improves systolic functions.[13]

A study done in 2017-2018 showed that the prevalence of impaired LV GLS (left ventricular global strain pattern) despite preserved LVEF in pre-dialysis and dialysis patients is relatively high. Patients with preserved LVEF but impaired LV GLS have an increased risk of HF hospitalization and all-cause mortality.[14]

LVM and LVMI also decreased significantly in our post hemodialysis patients. Similarly, Ganda et al in 2012 had shown in a study that LVMI decreased following hemodialysis initiation in CKD patients with symptomatic heart failure and reduced Left ventricular ejection fraction possibly due to relief of venous congestion, removal of uremic toxins as uremic toxins are supposed to have negative ionotropic effect on heart. Similarly, an increase in serum ionized calcium and reduction in acidemia after hemodialysis would be expected to exert positive ionotropic effect on heart.[15]

LV fractional shortening (FS) also increased in study patients following hemodialysis but it was not statistically significant. A study done by Nixon et al had showed that these changes in left ventricular function produced by regular hemodialysis are the combined effects of decrease in end diastolic volume and increase in contractile state of left ventricle.[16]

CONCLUSION

The above finding suggests that patients with Stage 4 and 5 CKD who were on hemodialysis there was significant improvement in various cardiac parameters apart from increase in left ventricular ejection fraction, which may lead to decrease morbidity and mortality in these patients.

However, this study had some limitations one was that study sample size was small. Second that impact of diabetes mellitus, hyperlipidemia, secondary hyperparathyroidism, homocysteine levels, and markers of inflammation could not be taken into account.

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