ORIGINAL RESEARCH

Echocardiographic assessment of cardiac functions in patients of chronic kidney disease stage v on hemodialysis

[1]Dr. Krishna Priya Agrawal, [2]Dr. Ajeet Singh Chahar, [3]Dr. Subhash Chandra, [4]Dr. Virendra Singh Saini, [5]Dr. Garima, [6]Dr. Nitu Chauhan, [7]Dr. Habibur Rahaman, [8]Dr. Anupam Shukla

[1]Senior Resident, Department of Critical Care Medicine, King George's Medical University, Lucknow, UP, India
[2,3]Associate Professor, Department of Medicine, S.N.Medical College, Agra, UP, India
[4]Associate Professor, Department of Medicine, S.M.M.H. Medical College, Saharanpur, UP, India
[5]Senior Resident, Department of Medicine, Autonomous State Medical College, Pilibhit, UP, India
[6]Associate Professor and Head, Department of Transfusion Medicine, S.N.Medical College, Agra, UP, India
[7,8]Junior Resident, Department of Medicine, S.N.Medical College, Agra, UP, India

Corresponding Author: Virendra Singh Saini, Associate Professor, Department of Medicine, S.M.M.H. Medical College, Saharanpur, UP, India **Email:** drvsaini1@gmail.com

ABSTRACT

Introduction: Chronic kidney disease (CKD) is emerging to be an important chronic disease globally due to rapidly increasing worldwide incidence of diabetes and hypertension. It encompasses a spectrum of pathophysiologic processes associated with abnormal kidney function and a progressive decline in glomerular filtration rate (GFR). The cardiovascular mortality in these individuals is 10to20fold more frequent than in the general population.Our study assess the pattern of echocardiographic changes in patients of CKD stage V on hemodialysis.
Method: This was a cross sectional study conducted on 100 patients with CKDstage V on maintenance hemodialysis for more than 3 months. All patients were subjected to detailed clinical examination and investigation like complete blood count, renal function tests, liver function tests, lipid profile, ECG, chest X ray PA view and echocardiography.
Results: Out of 100 cases, 58% were males and 42% females, most of them aged above 40 years with hypertension (61%) and diabetes (25%) as leading associated comorbidities. The presenting chief complaints were easy fatiguability (90%), nausea/vomiting (53%), dyspnoea (38%), edema (23%), decreased urine output (23%) and chest pain (10%), associated with pallor (51%), raised JVP (30%) and pedal edema (25%). ECG revealed ST-T changes (34%) as the most common finding, followed by sinus tachycardia (28%), LV hypertrophy (23%), other chambers abnormalities, conduction abnormalities and rhythm abnormalities. In Echocardiography, most common finding was diastolic dysfunction seen in 73% cases, followed by concentric left ventricular hypertrophy (54%), systolic dysfunction (25%), left ventricular enlargement (20%), global hypokinesia (15%), regional wall motion abnormalityof left ventricle (10%), ventricular ectopics (12%), atrial

fibrillation (8%), pericardial effusion (7%), aortic valve calcification (29%), mitral regurgitation (39%), mitral valve calcification (8%) and pulmonary arterial hypertension (42%).
Conclusion: The high association of diastolic dysfunction, left ventricular hypertrophy and systolic dysfunction on echocardiography implies that patients of CKD stage V on maintenance hemodialysis require routine echocardiography in all, despite absence of cardiac symptoms, so that timely efforts targeted at prevention and control of left ventricular hypertrophy and systolic dysfunction should be implemented asearlyas possible which may reduce cardiovascular mortality and morbidity in these patients.

INTRODUCTION

Chronic kidney disease is defined by the presence of kidney damage that generally refers to pathologic anomalies in the native or transplanted kidney, established via imaging, biopsy, or clinical markers like increased albuminuria—that is, albumin-to-creatinine ratio (ACR) >30 mg/g or urinary sediment alterations;or decreased kidney function that refers to a reduced glomerular filtration rate (GFR); for at least three months, irrespective of the cause. [1]CKD affectsmore than 10% of general population globally, about more than 800 million people worldwide.CKD is emerging to be one of the prominent cause of mortality and morbidity worldwide due to rapidly increasing global incidence of diabetes [2]and hypertension. [3]

CKD has been associatedwith increased risk for cardiovascular diseases. Cardiovascular complications remain the most common cause of death and disability in CKD patients.The cardiovascular mortality in these individuals is 10- to 20-fold more frequent than in the general population. Angina pectoris, myocardial infarction, dysrhythmia, left ventricular hypertrophy, cardiac failure, pericardial diseases, stroke and peripheral vascular disease are common in end stage renal disease. [4] This study identifies the cardiovascular changes and complications by echocardiographic assessment in patients of CKD stage V on maintenance haemodialysis to diagnose cardiac manifestations earlier to optimize the therapeutic interventions, which may lower morbidity and mortality.

METHOD

This was a crosssectional study conducted on 100 patients with chronic kidney disease stage V on maintenance hemodialysis for more than 3 months, admitted in Medicine department of Sarojini Naidu Medical College, Agra during the period September 2019 to March 2021. Only patients more 18 years of age were enrolled. All the 100 patients were subjected to detailed clinical examination and following investigations were done:

Complete hemogram, renal function test, serum electrolytes, liver function test, urine analysis and culture, renal ultrasound,lipid profile,chest X-ray posteroanterior view, Electrocardiography and Echocardiography.

RESULTS

1. Demography

The study included a total of 100 patients which included 58% males and 42% females. The age of the patients varied from 18 to 76 years. Age distribution suggests that a total of 51% belonged to age group of 41-60 years, suggesting that CKD is a disease of middle to elderly

aged population, followed by 42% cases aged above 60 years of age. Mean age of male was 55.41+/- 11.6 and among female was 58.12+/-12.65 years.

Table No. 1 (Age distribution)

Age group	Male		Female		Total	
	No.	%	No.	%	No.	%
≤20	2	3.45	1	2.38	3	3.00
21-40	2	3.45	2	4.76	4	4.00
41-60	35	60.34	16	38.10	51	51.00
>60	19	32.76	23	54.76	42	42.00
Total	58	100.00	42	100.00	100	100.00
Mean ±SD	55.41±11.60		58.12±12.65			

2. Associated comorbidities

In the present study, hypertension was the leading comorbidity with chronic kidney disease in (61%) patients, followed by diabetes in (25%), chronic glomerulonephritis (8%), pyelonephritis (4%), chronic urinary tract obstruction (4%), polycystic kidney disease (3%), analgesic nephropathy (3%) and IgA nephropathy (1%).

Table No. 2 (Associated Comorbidities)

Treatment / comorbidity	No. of cases	%
Analgesic nephropathy	3	3.00
CGN	8	8.00
DM	25	25.00
HTN	61	61.00
PCKD	3	3.00
Pyelonephritis	4	4.00
Chronic urinary tract obstruction	4	4.00
IgA nephropathy	1	1.00

3. Cardiovascular System Examination

Table no. 3 (Cardiovascular Examination Findings)

Cardiovascular examination	No. of cases (%)
Normal	81
Apical impulse shifted down and out	12
Pansystolic murmur in mitral area	12
Ejection systolic murmur in the aortic area	7
Pansystolic murmur in tricuspid area	6
Early diastolic murmur in Erb's area	3
Muffled heart sounds	2
Pericardial rub	2

Cardiovascular examination in chronic kidney disease stage V patients on hemodialysis shows shifting of apical impulse down and out in 12% and pansystolic murmur in mitral area in 12%, ejection systolic murmur of aortic stenosisin 7%, pansystolic murmur in tricuspid area in 6% and early diastolic murmur of aortic regurgitation was present in 3% patients. Muffled heart sounds and pericardial rub were present in 2% each.

4. Electrocardiography

In the present study, electrocardiogram showed that majority of patients had ST-T changes that accounted for 34%, followed by sinus tachycardia (28%), LV hypertrophy (23%), left atrial abnormality (14%), right atrial abnormality (10%) and right ventricular hypertrophy (10%). Conduction abnormalities noted as left anterior fascicular block (22%), left bundle branch block (18%), left posterior fascicular block (3%), right bundle branch block (10%) and first-degree heart block (3%). Rhythm abnormalities noted on ECG were atrial fibrillation (16%), ventricular premature complexes (12%) and atrial premature complexes (6%). Low voltage complexes were seen in 2% patients.

Table no. 4 (Electrocardiogram changes)

Electrocardiogram	No.	%
LVH	23	23.00
RVH	10	10.00
LAA	14	14.00
RAA	10	10.00
ST T changes	34	34.00
Sinus tachycardia	28	28.00
LAHB	22	22.00
LPHB	03	03.00
LBBB	18	18.00
RBBB	10	10.00
I degree heart block	03	03.00
AF	16	16.00
APC	06	06.00
VPC	12	12.00
Low voltage complexes	02	02.00

5. Echocardiography

In our study, diastolic dysfunction and concentric left ventricular hypertrophy were the most common abnormalities detected in echocardiography. Diastolic dysfunction accounted for 73% followed by concentric hypertrophy of left ventricle in 54% patients. Grade I diastolic dysfunction (48%), grade II diastolic dysfunction (10%) and grade III diastolic dysfunction (15%) was noted during the study. Diastolic dysfunction was more common in old age and hypertensives. Pulmonary arterial hypertension seen in 42%, followed by valve abnormalities that were mitral regurgitation (39%), aortic valve calcification (29%) and mitral valve calcification (8%). Systolic dysfunction was found in 25% cases, out of which 15% have mild systolic dysfunction, 6% have moderate and 4% have severe systolic dysfunction. Chambers abnormalities included dilated left ventricle and dilated left atrium seen in 20% patients each. Global hypokinesia of left ventricle was noted in 15% and regional wall motion abnormalities in 10% patients. Rhythm abnormalities seen as 8% had atrial fibrillation, followed by ventricular ectopics (12%) and atrial premature complexes (8%). Pericardial effusion noted in 7% cases and they were having higher blood urea level.

Table no. 5 (Echocardiographic abnormalities seen in CKD stage V on hemodialysis)

Diastolic dysfunction	73%
Concentric LVH	54%
Pulmonary arterial hypertension	42%
Systolic dysfunction	25%
Dilated LV	20%
Dilated LA	20%
Global hypokinesia of left ventricle	15%
Regional wall motion abnormalities	10%
Rhythm abnormalities	09%
Mitral regurgitation	39%
Mitral valve calcification	12%
Aortic valve calcification	29%
Aortic regurgitation	8%
Pericardial effusion	7%
Normal	27%

DISCUSSION

According to the U.S. Renal Data System report published in 2013, 43% of patients with CKD and CVD had heart failure (HF), and 15% had a history of acute myocardial infarction (AMI). [5]It has been acknowledged that patients with advanced kidney disease, stage 4 or 5, are at high risk of cardiovascular disease morbidity and mortality. [6] The risk of CVD in CKD varies with the degree of renal impairment and proteinuria. The traditional risk factors for CVD such as increasing age, hypertension, dyslipidaemia, diabetes, smoking, and obesity are risk factors for CKD as well and hence are common in patients with CKD. The non-traditional or novel risk factors are uremic specific and are more common in patients with CKD than in the general population. These include albuminuria, anaemia, hyperparathyroidism, metabolic bone disease, hyperhomocysteinemia, malnutrition, apolipoprotein isoforms, inflammation, endothelial dysfunction and oxidative stress. The various risk factors traditional and non-traditional tend to have an additive effect and hasten atherosclerosis and progression of CKD.

A crosssectional study was conducted at Post Graduate Department of Medicine, Sarojini Naidu Medical College and Hospital, Agra for a period of 19 months from September 2019 to March 2021, on 100 admitted patients of chronic kidney disease stage V on haemodialysis for more than 3 months. Out of 100, 58% were males and 42% were females. No significant difference was found in proportion of males and females. This sex distribution was consistent with Manfred Hecking et al study [7] and Farah Anum Jameel et al (2020). [8] The study population comprised of adults in age group of 18 to 76 years and most of the patients belongs to 41 to 60 years. The mean age was 56 years, with mean age in males being 55 years and in females was 58 years. Age distribution was consistent with G K Modi et al study, M Hida et al study and Farah Anum Jameel et al study.[8]

In our study, hypertension was the leading comorbidity with chronic kidney disease in 61% patients, followed by diabetes (25%), chronic glomerulonephritis (8%), pyelonephritis (4%), chronic urinary tract obstruction (4%), polycystic kidney disease (3%), analgesic nephropathy (3%) and IgA nephropathy (1%). This was consistent with Clare MacRae et al study in which hypertension was 71.2% (versus 17.0% in controls), followed by coronary artery disease with 34.5% (versus 5.6%), and diabetes with 26.3% (versus 5.2%) were the associated comorbidities in CKD.[9] This was also in consistent with Mukesh Laddha et al study. [10]

Electrocardiogram showed that most patients had ST-T changes, followed by sinus tachycardia. LV hypertrophy was most common chamber abnormality followed by left atrial

abnormality, right atrial abnormality and right ventricular hypertrophy. These findings were consistent with study done by Mukesh Laddha et al. [10]they found that ECG changes in decreasing order of frequency were sinus tachycardia in 48.6%, LVH in 45.7%, ST -T changes in 30%, ventricular ectopics and Tall 'T' wave in 7.1%, QT prolongation and low voltage pattern in 5.7%, ventricular tachycardia in 2.9% and complete heart block in 1.4% was noted.[70]Mostcommonconduction abnormalities on ECG in our study was left anterior fascicular block followed by left bundle branch block, left posterior fascicular block, right bundle branch block and first degree heart block. Similarly, S. Shafi et al (2017) in their study found that overall, 78.4% of all CKD patients have one or more ECG abnormality, Left ventricular hypertrophy (40%), Q waves (27.2%), ST segment elevation or depression (23.4%), prolonged QRS duration (19.2%), tachycardia (17.6%) and left and right atrial enlargement (17.6%) were the most common abnormalities. [11]

In Echocardiography of patients diastolic dysfunction was found in 73% patients in consistent with Mukesh Laddha et al [10] and NP Singh et al. [12] Grade I diastolic dysfunction in 48 patients, grade II in 10% and grade III in 15%. These 25 patients with grade II and III diastolic dysfunction also had systolic dysfunction. Out of these 73patients, 39 had concentric left ventricular hypertrophy and 14 patients had dilated left ventricle. We found thatout of 73 patients of diastolic dysfunction, 36 (49.31%) patients were of age group 41-60 years of age, 33 (45.20%) patients in age group more than 60 years, similarly with respect to associated comorbidities, 44(60.27%) patients were hypertensives, 18 (24.65%) diabetics. Therefore, we can conclude that diastolic dysfunction is more common in elderly and hypertensives. This was in consistent with various studies like of Sameer Al- Ghamdi et al and Sophie Lalande and Bruce D. Johnson study.

Concentric left ventricular hypertrophy (54%)was the second common abnormality detected next to diastolic dysfunction in consistent with Parfrey PS et al [5]and Dai Y et al studies.About 20% patients in the study had dilated left ventricle similar to the study done by Parfrey PS et al.[5]Dilated left atrium was present in 20 cases and those 20 had dilated left ventricle and systolic dysfunction, similar to Leia Hee et al[13] and Praveen Garg et al.

Systolic dysfunction was found in 25% patients. This was comparable with the Study byBarde et al [14] Parfrey PS et al [5] and Mukesh Laddha et al studies. [10] Mild systolic dysfunction in 15%, moderate and severe systolic dysfunction accounted for 6% and 4% respectively. 15 patients had global hypokinesia of left ventricle with systolic and diastolic dysfunction.Out of 25 patients of systolic dysfunction, 16 (64.00%) were of age more than 60 years, 7 (28%) between 41-60 years; with respect to associated comorbidities, 15 (60%) were hypertensives, 7 (28%) diabetics. We can conclude that systolic dysfunction is more common in old age, hypertensives and diabetics. This was consistent with Jasper Tromp et al studyand Daniel Tiller et al study.

Pericardial effusion was found in 7% cases. Two patients hasmoderate effusion and low voltage QRS complexes in ECG and cardiomegaly in chest X-Ray. About 5% in the study had no cardiac symptoms but proved to have pericardial effusion. This was comparable to Gupta et al and Barde et al studies. [14] We found that patients with pericardial effusion had higher blood urea levelin consistent with Kay-Won Chang et al study.

Aortic valve calcification seen in 29%, mitral regurgitation 39%, mitral valve calcification 8%, rest valvular abnormalities included trivial tricuspid regurgitation and trivial aortic regurgitation were noted in consistent with Barde et al [14] and Laddha et al studies. [10]

CONCLUSION

CKD was more common in middle and old age group.Hypertension (61%) and Diabetes (25%) were the leading comorbidities with chronic kidney disease, followed by chronic glomerulonephritis (8%), pyelonephritis (4%), chronic urinary tract obstruction (4%), polycystic kidney disease (3%), analgesic nephropathy (3%) and IgA nephropathy (1%). ECG revealed ST-T changes (34%) as the most common finding, followed by sinus tachycardia (28%), LV hypertrophy (23%), followed by other chambers abnormalities, conduction abnormalities and rhythm abnormalities. In Echocardiography, most common finding was diastolic dysfunction seen in 73% cases, followed by concentric left ventricular hypertrophy (54%), systolic dysfunction (25%), left ventricular enlargement (20%), global hypokinesia (15%), regional wall motion abnormalityof left ventricle (10%), ventricular ectopics (12%), atrial fibrillation (8%), pericardial effusion (7%), aortic valve calcification (29%), mitral regurgitation (39%), mitral valve calcification (8%) and pulmonary arterial hypertension (42%) were noted. The high association of diastolic dysfunction, left ventricular hypertrophy and systolic dysfunction on echocardiography implies that patients of CKD stage V on maintenance hemodialysisrequire routine echocardiography in all despite absence of symptoms, and also that timely efforts targeted at prevention and control of left ventricular hypertrophyshould be implemented as early as possible such as effective and maintained control of hypertension, anemia and volume overload which may reduce cardiovascular mortality and morbidity in these patients.

REFERENCES

1. K.M. Andrassy, Comments on 'KDIGO 2012 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease', Kidney International 84 (2013) 622–623.
2. Wild S, Roglic G, Green A, Sicree R, King H: Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. Diabetes Care. 2004, 27 (5): 1047-53.
3. Gupta R: Trends in hypertension epidemiology in India. J Hum Hypertens. 2004, 18 (2): 73-8. 10.1038/sj.jhh.1001633.
4. Mann JFE, et al. Cardiovascular risk in patients with mild renal insufficiency. Kidney Int, Vol 63 (Suppl 84) , 2003; S192 – S196.
5. Parfrey PS, Foley RN, Harnett JD, et al: Outcome and risk factors for left ventricular disorders in chronic uremia. Nephrol Dial Transplant, 1996; 11: 1277-1285.
6. Parfrey PS, Foley RN, Harnett JD, et al: Outcome and risk factors for ischemic heart disease in chronic uremia. Kidney Int, 1996; 49: 1428-1434.
7. Hecking M, Bieber BA, Ethier J, Kautzky-Willer A, Sunder-Plassmann G, et al. (2014) Sex-Specific Differences in Hemodialysis Prevalence and Practices and the Male-to-Female Mortality Rate: The Dialysis Outcomes and Practice Patterns Study (DOPPS). PLoS Med 11(10): e1001750. doi:10.1371/journal.pmed.1001750
8. Jameel F, Junejo A, Khan Q, et al. (July 02, 2020) Echocardiographic Changes in Chronic Kidney Disease Patients on Maintenance Hemodialysis. Cureus 12(7): e8969. DOI 10.7759/cureus.8969
9. MacRae C, Mercer SW, Guthrie B, Henderson D. Comorbidity in chronic kidney disease: a large cross-sectional study of prevalence in Scottish primary care. Br J Gen Pract. 2021 Feb 25;71(704):e243-e249. doi: 10.3399/bjgp20X714125. PMID: 33558333; PMCID: PMC7888754.
10. Mukesh Laddha et al. Echocardiographic Assessment of Cardiac Dysfunction in Patients of End Stage Renal Disease on Haemodialysis.J Assoc Physicians India. 2014 Jan;62(1):28-32. PMID: 25327089.

11. Shafi, S. & Saleem, M. & Anjum, R. & Abdullah, W. & Shafi, T.. (2017). ECG Abnormalities In Patients With Chronic Kidney Disease. Journal of Ayub Medical College, Abbottabad : JAMC. 29. 61-64.
12. Singh NP, Chandrashekar, M Nair. The cardiovascular and hemodynamic effects of erythropoietin in CRF. JAPI 2000;48:301-306.
13. Hee L, Nguyen T, Whatmough M, Descallar J, Chen J, Kapila S, French JK, Thomas L. Left atrial volume and adverse cardiovascular outcomes in unselected patients with and without CKD. Clin J Am Soc Nephrol. 2014 Aug 7;9(8):1369-76.
14. Barde R, Patel HV, Shah P. A study of echocardiographic changes in CKD patients on maintenance hemodialysis: A study centre study. JEBMH 2015;2:6626-34.