e-ISSN: 0976-822X, p-ISSN:2861-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2023; 15(3); 158-165

Original Research Article

A Hospital Based Observational Assessment of Cardiac Functions in Patients with Chronic Kidney Disease (CKD)

Pushp Raj Kumar

Senior Resident, Department of General Medicine, AIIMS Patna, Bihar, India

Received: 02-01-2023 / Revised: 19-02-2023 / Accepted: 15-03-2023
Corresponding author: Dr. Pushp Raj Kumar
Conflict of interest: Nil

Abstract

Aim: The aim of the present study was to assess the cardiac functions in patients with chronic kidney disease (CKD).

Methods: An observational study was carried out in 100 patients from department of medicine from AIIMS Patna, Bihar, India for the period of one year after obtaining an approval from institutional ethics committee. Data were collected in the predesigned Patient Profile Form along with complete laboratory reports and all relevant history. All the patients were gone through two-dimensional and M mode echocardiography for determination of their cardiac functions.

Results: This study included 100 patients with 60 (60%) male and 40 (40%) female who were diagnosed with chronic kidney disease (stage 1 to 5) or End stage renal disease based on laboratory interpretation of GFR (<90 ml/min/1.73 m2) and serum creatinine (>3 mg/dl). Among that 65 (65%) patients were hypertensive (BP >140/90 mmhg) and 35 (35%) were normotensive. Echocardiography showed that left ventricular hypertrophy (LVH) was present in 75 (75%). Systolic dysfunction as measured by reduced fractional shortening (<25%) and decreased LVEF (<52%) was present in (8) 8% and 18 (12%) respectively. In hypertensive patients with CKD, LVH was present in 40 patients, diastolic dysfunction was present in 45 patients as deliberate by abnormal E/A ratio, systolic dysfunction as considered by reduced LVEF was present in 7 patients and pericardial effusion observed in 17 patients.

Conclusion: LV diastolic dysfunction also happens in patients who having the early stage of CKD. Hypertensive patients along with CKD had found higher widespread presence of diastolic and systolic dysfunction as compared to normotensive.

Keywords: CKD, Dysfunction, Echocardiography, Hypertension.

Introduction

Heart failure (HF) is a heterogeneous clinical syndrome resulting from injury and cardiac overload that in consequence leads to the elevation of intracardiac pressure and inadequate cardiac output. Due to left ventricular ejection fraction (LVEF), HF is divided into three main categories: HF with preserved (HFpEF; LVEF ≥ 50%), mildly reduced (HFmrEF; LVEF 41–49%), and reduced ejection fraction (HFrEF; LVEF ≥40%). [1] Nevertheless, right ventricle dysfunction can also result in HF. Patients suffering from HF are at high risk of comorbidities which are strictly connected with higher mortality risk, increased burden of healthcare costs, and adverse outcomes. [2,3] Additional chronic conditions are a major concern in heart failure. According to Chamberlain's research [3], most heart

failure patients have at least two chronic conditions. Furthermore, patients with HFpEF present an increased number of comorbidities compared to patients with HFrEF. The heart and kidney are closely related. Their role is to maintain salt–water homeostasis and normal blood pressure. The Renal impairment and disturbance of salt and water excretion resulted in an increase in cardiac preload and afterload. Furthermore, low cardiac output can decrease kidney perfusion and lead to kidney failure. Therefore, renal impairment is one of the most serious consequences of HF. [4]

The extremity of CKD can be proficient by a reasonable serum creatinine-based estimated glomerular filtration rate (eGFR), which also indicates excretory kidney function, and elevated urinary albumin measured by the urinary albumin-to-creatinine ratio (ACR), which is a best predictor of kidney damage. [5] In 2017, the worldwide prevalence of CKD was 9.1% (95% uncertainty interval [UI] 8.5 to 9.8), which is roughly estimated 700 million cases. Since 1990, the prevalence of CKD has intensified by 29.3% (26.4 to 32.6), but age-standardized prevalence has remained untouched during this period (1.2%, -1.1 to 3.5). A worthwhile rise was noted in age-standardized incidence of end-stage kidney disease (ESKD) which is treated by renal replacement therapy, with dialysis and kidney transplantation. The global strengthen in mortality from CKD since 1990 was 41.5% (95% UI 35.2 to 46.5), such that mortality from CKD, and cardiovascular disease deaths in debt to impede kidney function caused 4·6% (4.3 to 5) of worldwide deaths in 2017, which manifested that CKD is the 12th leading cause of death globally in 2017, as an increase from 17th in 1990. [6]

High blood pressure (BP) is the most considerable risk factor for the development and progression of CKD as well as more deaths and disease worldwide than any other single health risk factor. [7-9] Early detection of high BP and its appropriate management is required as possible as to makes a difference in the prevention of CKD progression and control of the CKD health burden. [10]

The aim of the present study was to assess the cardiac functions in patients with chronic kidney disease (CKD).

Materials and Methods

An observational study was carried out in 100 patients from department of medicine from AIIMS Patna, Bihar, India for the period of one year after obtaining an approval from institutional ethics committee. Data were collected in the predesigned Patient Profile Form along with complete laboratory reports and all relevant history. All the patients were gone through two-dimensional and M mode echocardiography for determination of their cardiac functions. The analysis made from the data was reported in predesigned forms which includes information such as patient demographic details (BP, all vitals, weight, medical & medication history) and required laboratory information (Serum creatinine, GFR).

All patients were evaluated physically, clinically, biochemically and radiological test were done as per discretion of physician. Additionally, all required examinations were performed as and when required.

Echocardiography was executed using a cardiac ultrasound unit with a 2-3.5 MHz transducer. TDI was performed in all patients with images taken. Left ventricular end-diastolic, systolic dimensions, end-diastolic, and systolic wall thickness of the inter-ventricular septum and left ventricular wall were determined using standard echocardiography2-D and M-mode measurements. M mode recording perpendicular to the long axis of and through the center of the left ventricle at the papillary muscle level were taken as standard measurements of the systolic and

diastolic wall thickness and chamber dimensions. The LVEF and fractional shortening (FS) were taken as measure of left ventricular systolic function. 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.

Inclusion criteria

Patients with age about > 18 years, GFR should be <90 ml/min/ 1.73 m2, serum creatinine >3 mg/dl and subjects having confirm diagnosis of CKD >6 month were included in the study.

Exclusion criteria

Pregnant, lactating women, mentally ill or other psychological subjects, subject who are on antineoplastic medication, post traumatic patient, patient who had severe coarse of COVID-19 and other comorbid disease or condition which can interfere with study as per investigators discretion were excluded from the study.

Biochemical estimations

Physical examination, all vitals, GFR, serum creatinine, CBC, cardiac biomarker, kidney function test and echocardiography were performed. Additional tests were performed based on investigator discretion as applicable.

Statistical analysis

The data was represented graphically in MS-excel with median values.

Results

Table 1: Subject's demography including clinical characteristic

Variables		**Total, n (%)**
Age (Years)		18- 75 (Mean 56±12)
Gender	Male	60 (60)
	Female	40 (40)
BMI (mean) (kg/m^2)		25.5
	Hypertensive	65 (65)
	Normotensive	35 (35)
	Haemodialysis	40 (40)
	End-stage renal disease (Stage 4 and 5)	45 (45)
	Diabetes	36 (36)
Clinical characteristics	Reduced urine output	70 (70)
	Nocturia	28 (28)
	Haematuria	12 (12)
	Pruritus	13 (13)
	Pallor	64 (64)
	Pedal oedema	60 (60)
	Proteinuria	48 (48)
	Primary	54 (54)
Educational status	Secondary	20 (20)
	Tertiary	12 (12)
	None	14 (14)
	Employed	40 (40)
Occupation	Unemployed	38 (38)

	Others	22 (22)
	Married	60 (60)
Marital status	Single	15 (15)
	Others	25 (25)

This study included 100 patients with 60 (60%) male and 40 (40%) female who were diagnosed with chronic kidney disease (stage 1 to 5) or End stage renal disease based on laboratory interpretation of GFR (<90 ml/min/1.73 m2) and serum creatinine (>3 mg/dl). Among that 65 (65%) patients were hypertensive (BP >140/90 mmhg) and 35 (35%) were normotensive.

Table 2: Analyzed patients based on CKD stages

Stage of CKD	Hypertensive	Normotensive
Stage 1 (GFR 90or higher)	5	5
Stage 2 (GFR 89 to 60)	7	5
Stage 3a (GFR59 to 45)	7	7
Stage 3b (GFR44 to 30)	10	15
Stage 4 (GFR 29 to 15)	12	8
Stage 5 (GFR less than 15)	9	10

The subjects were classified in to 5 groups based on GFR. We also found that E/A increased in parallel with the severity of kidney dysfunction, apart from patients with very advanced CKD.

Table 3: Echocardiographic findings in ESRD study cases

Echocardiographic finding in cases of ESRD	No. of cases	Percentage (%)
Left ventricularhypertrophy	75	75
Fractional shortening(<25%)	8	8
Ejection fraction (<50%)	12	12
E/A ratio (<0.75 or >1.8)	60	60
RWMA	12	12
Pericardial effusion (<10mm)	15	15
Valvular calcification	8	8

Echocardiography showed that major contributing factors for left ventricular hypertrophy and diastolic dysfunction were hypertension. Major contributing factor for systolic dysfunction was RWMA due to ischemic heart disease. Echocardiography showed that left ventricular hypertrophy (LVH) was present in 75 (75%). Systolic dysfunction as measured by reduced fractional shortening (<25%) and decreased LVEF (<52%) was present in (8) 8% and 18 (12%) respectively.

Table 4: Correlation analyses according to echocardiography finding in hypertensive and normotensive ESRD study

Echocardiographic finding in cases of ESRD	Hypertensive, n (%)		Normotensive, n (%)	
	Present	Absent	Present	Absent
Left ventricular hypertrophy	40	5	30	25
Fractional shortening (<25%)	15	35	5	45
Ejection fraction (<50%)	7	40	3	40
E/A ratio (<0.75 or >1.8)	45	5	20	30

RWMA	16	35	4	45
Pericardial effusion (<10 mm)	17	38	3	42
Valvular calcification	14	36	5	44

In hypertensive patients with CKD, LVH was present in 40 patients, diastolic dysfunction was present in 45 patients as deliberate by abnormal E/A ratio, systolic dysfunction as considered by reduced LVEF was present in 7 patients and pericardial effusion observed in 17 patients.

Discussion

Cardiovascular disease (CVD) is the supreme cause of morbidity and mortality amid patients with CKD. In spite of alteration for known CAD risk factors, including hypertension and diabetes and mortality risk dynamically intensifying with worsening condition of CKD.11 Chronic kidney disease is a non-communicable disease typically caused by diabetes and hypertension. [12] The concept that CVD and CKD can initiate and perpetuate one another led to the creation of cardio renal syndrome as a separate clinical entity. [13] The mechanism underlying the increased risk of cardiovascular events in patients with CKD has not been well defined. Several factors are believed to be responsible for such an association. Even after adjusting for the coexisting multiple risk factors, CKD appears to be the major factor in determining cardiovascular morbidity and mortality. [14]

In hypertensive patients with CKD, LVH was present in 40 patients, diastolic dysfunction was present in 45 patients as deliberate by abnormal E/A ratio, systolic dysfunction as considered by reduced LVEF was present in 7 patients and pericardial effusion observed in 17 patients. Rao et al found that 67.2% of subjects had diastolic dysfunction. [15] Losi et al in a cross-sectional study declare that nearly 40% of the patients had diastolic dysfunction. [16] Agrawal et al had distinguish a prevalence of diastolic dysfunction of 30% in early stages of CKD and 53.2% in later stages of CKD. [17]

Moreover, systolic dysfunction in 8 (8%) basically related with coronary artery disease hence major determinant of prognosis. It is present in greater proportion in later stages of CKD. Similarly, a study by Kulkarni et al and Foley et al concluded that systolic dysfunction was present in 29 (41.4%) and 14.8 % patients. [18,19] A study by Singh et al. [20] LV systolic dysfunction was 15.6%. Furthermore, systolic dysfunction was reported 24.6% with CKD in a European multicenter study reported by Chinali et al but higher than the 8.3% reported by Adiele et al. [21,22] These findings suggest that there is a significant burden of LV systolic and diastolic dysfunction in CKD patients. We found LVEF was present in 12 (12%). Similar result was also stated by Shin et al that LVEF was present in 57.2% of hemodialysis patients. [23] Hensen et al LVEF was observed in 32% of patients although same was higher as compared to our study. [24]

Echocardiography showed that left ventricular hypertrophy (LVH) was present in 75 (75%). Systolic dysfunction as measured by reduced fractional shortening (<25%) and decreased LVEF (<52%) was present in (8) 8% and 18 (12%) respectively. Similar result were also produced by Hayashi et al and Foley et al that LV hypertrophy was observed in 63% and 73.4% patient by Ramegowda et al left ventricular hypertrophy was seen in 24 patients (48%). [19,25,26] Ejection fraction (<50%) was detected in 12% patients similar result were also concluded by Mavrakanas et al. [27] That EF was confirmed in 12.7% patients. Another study by Hensen et al have similar result

that LVEF was observed in 32% of patients. [24]

Most common Echocardiographic abnormality was Left ventricular hypertrophy followed by conduction abnormalities, E/A ratio, pericardial effusion and RWMA. Left ventricular hypertrophy is the commonest morphological abnormality observed in our study, followed by RWMA. Left ventricular dysfunction is commonest cardiovascular abnormality detected. Echocardiography is a more sensitive diagnostic procedure to detect left ventricular dysfunction in patients with CKD. [28] As the stages of CKD progresses spike ECHO abnormalities were observed like left ventricular hypertrophy, systolic dysfunction, LVDD, regional wall motion abnormalities and pericardial effusion.

Conclusion

We concluded that left ventricular diastolic dysfunction also occurs in patients having early stage of CKD but patients with hypertensive CKD had higher prevalence of diastolic and systolic dysfunction as compared to normotensive counterparts and that Doppler indices combined with conventional and TDI can be used to detect subtle changes of diastolic function due to kidney dysfunction. Also, CKD causes a systemic, chronic pro-inflammatory state contributing to vascular and myocardial remodeling. In this respect to our study, CKD mimics a hastened aging of the cardiovascular system.

References

1. McDonagh, T.A., Metra, M., Adamo, M., Gardner, R.S., Baumbach, A., Böhm, M., Burri, H., Butler, J., Čelutkienė, J., Chioncel, O. and Cleland, J.G., 2021. 2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure: Developed by the Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC) With the special contribution of the Heart Failure Association (HFA) of the ESC. European heart journal, 42(36), pp.3599-3726.
2. Mogensen UM, Ersbøll M, Andersen M, Andersson C, Hassager C, Torp-Pedersen C, Gustafsson F, Køber L. Clinical characteristics and major comorbidities in heart failure patients more than 85 years of age compared with younger age groups. European journal of heart failure. 2011 Nov;13(11):1216-23.
3. Chamberlain AM, Sauver JL, Gerber Y, Manemann SM, Boyd CM, Dunlay SM, Rocca WA, Rutten LJ, Jiang R, Weston SA, Roger VL. Multimorbidity in heart failure: a community perspective. The American journal of medicine. 2015 Jan 1;128(1):38-45.
4. Damman K, Voors AA, Navis G, van Veldhuisen DJ, Hillege HL. The cardiorenal syndrome in heart failure. Progress in cardiovascular diseases. 2011 Sep 1;54(2):144-53.
5. Van Der Velde M, Matsushita K, Coresh J, Astor BC, Woodward M, Levey AS, de Jong PE, Gansevoort RT, Chronic Kidney Disease Prognosis Consortium. Lower estimated glomerular filtration rate and higher albuminuria are associated with all-cause and cardiovascular mortality. A collaborative meta-analysis of high-risk population cohorts. Kidney international. 2011 Jun 2;79(12):1341-52.
6. Cockwell P, Fisher LA. The global burden of chronic kidney disease. The Lancet. 2020 Feb 29;395(10225):662-4.
7. Lim SS, Vos T, Flaxman AD, Danaei G, Shibuya K, Adair-Rohani H, AlMazroa MA, Amann M, Anderson HR, Andrews KG, Aryee M. A comparative risk assessment of burden of disease and injury attributable to 67

risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. The lancet. 2012 Dec 15;380(9859):2224-60.
8. Barri YM. Hypertension and kidney disease: a deadly connection. Current hypertension reports. 2008 Feb;10(1): 39-45.
9. Turner G, Wiggins K, Johnson D. Cari Guidelines: Primary prevention of chronic kidney disease: blood pressure targets. Westmead: Kidney Health Australia. 2012.
10. Australian Institute of Health and Welfare. Cardiovascular disease, diabetes and chronic kidney disease—Australian facts: risk factors. Cardiovascular, diabetes and chronic kidney disease series no 4 cat no CDK 4. Canberra: AIHW. 2015.
11. Chronic Kidney Disease Prognosis Consortium. Association of estimated glomerular filtration rate and albuminuria with all-cause and cardiovascular mortality in general population cohorts: a collaborative meta-analysis. The Lancet. 2010;375 (9731):2073-81
12. Webster AC, Nagler EV, Morton RL, Masson P. Chronic kidney disease. The lancet. 2017 Mar 25;389(10075):1238-52.
13. Braam B, Joles JA, Danishwar AH, Gaillard CA. Cardiorenal syndrome—current understanding and future perspectives. Nature Reviews Nephrology. 2014 Jan;10(1):48-55.
14. Anavekar NS, Pfeffer MA. Cardiovascular risk in chronic kidney disease. Kidney Int 2004;66: S11–15.
15. Rao T, Karwa M, Wanjari A. Left ventricular dysfunction among chronic kidney disease patients: a cross sectional study. Int J Adv Med. 2018 Sep; 5:1093-9.
16. Losi MA, Memoli B, Contaldi C, Barbati G, Del Prete M et al. Myocardial fibrosis and diastolic dysfunction in patients on chronic haemodialysis. Nephrology, Dialysis, Transplant. 2010;25(6):1950-4.
17. Agrawal S, Dangri P, Kalra O, Rajpal S. Echocardiographic assessment of cardiac dysfunction in patients of chronic renal failure. J Indian Acad Clin Med. 2003;4(4):297
18. Kulkarni IJ, Mane MB. Assessment of Cardiac Function in Patients of Chronic Kidney Disease. Ann Rom Society Cell Biol. 2021 Apr 15:6091-6.
19. Foley RN, Parfrey PS, Harnett JD, Kent GM, Murray DC, Barre PE. The prognostic importance of left ventricular geometry in uremic cardiomyopathy. Journal of the American Society of Nephrology. 1995 Jun 1;5(12):2024-31.
20. Singh S, Aggarwal V, Pandey UK, Sreenidhi HC. Study of left ventricular systolic dysfunction left ventricular diastolic dysfunction and pulmonary hypertension in CKD 3b-5ND patients—A single centre cross-sectional study. Nefrología. 2022 Jun 22.
21. Chinali M, De Simone G, Matteucci MC, Picca S, Mastrostefano A, Anarat A, Caliskan S, Jeck N, Neuhaus TJ, Peco-Antic A, Peruzzi L. Reduced systolic myocardial function in children with chronic renal insufficiency. Journal of the American Society of Nephrology. 2007 Feb 1;18 (2):593-8.
22. Adiele DK, Okafor HU, Ojinnaka NC, Onwubere BJ, Odetunde OI, Uwaezuoke SN. Echocardiographic findings in children with chronic kidney disease as seen in the resource-limited setting. J Nephrol Ther. 2014; 4:158-61.
23. Shin DH, Lee YK, Oh J, Yoon JW, Rhee SY, Kim EJ, Ryu J, Cho A, Jeon HJ, Choi MJ, Noh JW. Vascular calcification and cardiac function according to residual renal function in patients on hemodialysis with urination. PloS one. 2017 Sep 27;12(9):e0185296.

24. Hensen LC, Goossens K, Delgado V, Abou R, Rotmans JI, Jukema JW, Bax JJ. Prevalence of left ventricular systolic dysfunction in pre-dialysis and dialysis patients with preserved left ventricular ejection fraction. European journal of heart failure. 2018 Mar; 20(3):560-8.
25. Hayashi SY, Rohani M, Lindholm B, Brodin LÅ, Lind B, Barany P, Alvestrand A, Seeberger A. Left ventricular function in patients with chronic kidney disease evaluated by colour tissue Doppler velocity imaging. Nephrology Dialysis Transplantation. 2006 Jan 1;21(1):125-32.
26. Ramegowda RB, Samdeshi AL, Khanvilkar Y. A study of Echocardiographic changes in patients with chronic kidney disease in a tertiary care centre in South Karnataka. 2018;7.
27. Mavrakanas TA, Khattak A, Wang W, Singh K, Charytan DM. Association of Chronic Kidney Disease with preserved ejection fraction heart failure is independent of baseline cardiac function. Kidney and Blood Pressure Research. 2019;44(5):1247-58.
28. Atbib Y., Essad A., Zhar H., Tadlaoui Yasmina, Ait El Cadi, M., & Bousliman Y. Impact de l'immunothérapie dans la prise en charge du cancer du poumon. Etude rétrospective menée à l'Hôpital Militaire d'Instruction Mohammed V-Rabat. Journal of Medical Research and Health Sciences, 2022; 5(9): 2221–2243.