# Echocardiographic Abnormalities in Children with Chronic Kidney Disease on Maintenance Hemodialysis

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## ABSTRACT

***Objective:*** To identify the echocardiographic abnormalities in children with chronic kidney disease on maintenance hemodialysis.

***Study Design:*** Prospective longitudinal study.

***Place and Duration of Study***: Hemodialysis unit of Department of Pediatric Nephrology, The Children's Hospital and Institute of Child Health, Lahore from Jun to Nov 2020.

***Methodology:*** A total of 75 children of chronic kidney disease on hemodialysis were included. Blood and urine tests, chest x-ray and transthoracic echo cardio-grapy were performed to assess the cardiac morphological and functional abnormalities.

***Results:*** The mean age of patients was 12.14 ± 2.18 years with 54 (72%) males and 21 (28%) females. The mean duration of hemodialysis was 22.54 ± 17.01 months with mean urea reduction ratio (URR) (%) 65.58 ± 4.31 and mean Kt/v 1.3 ± 0.1. Hypertension was noted in 70 (93.3%) patients with mean systolic and diastolic blood pressure 134.07 ± 10.64 and 89.13 ± 6.78 mmHg, respectively. The echocardiography revealed the mean ejection fraction of 58.02 ± 12.40 with mild systolic and diastolic dysfunction noted in 48 (64%) patients, pericardial effusion in 23 (30.7%) cases and left ventricular hypertrophy (LVH) in 52 (69.3%) cases.

***Conclusion:*** As the frequency of left ventricular hypertrophy (LVH) was noted to be high in our chronic kidney disease patients on hemodialysis, there is a need to implement echocardiographic screening of these patients at regular intervals to identify and rectify cardiac complications early.

**Keywords:** Chronic kidney disease, Cardiovascular disease, Echocardiography, Hemodialysis.

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## INTRODUCTION

Chronic Kidney Disease (CKD) is defined as renal damage due to structural or functional abnormality involving laboratory, pathological or imaging findings for >3 months and GFR <60 ml/1.73 $m^2$/min.[1] In children aged less than five years, most cases of CKD occur due to congenital malformations of kidney anatomy and urinary tract, metabolic and genetic causes. At the same time, glomerular and tubular disorders are common causes in older children.[2] Patients diagnosed with ESRD are managed with dialysis, increasing the risk of cardiovascular diseases. Left ventricular hypertrophy and systolic or diastolic dysfunction are the two major complications commonly observed in hemodialysis patients and are diagnosed by echocardiography.

The incidence of chronic kidney disease is increasing. It is associated with cardiovascular complications, especially in children on hemodialysis, contributing to significant morbidity and mortality.[3] Application of echocardiography to the pediatric population with CKD is attractive due to its noninvasive nature. Furthermore, left ventricular hypertrophy (LVH), systolic and diastolic dysfunction, and many other cardiac abnormalities in chronic kidney disease can be detected by this technique.[4,5] It is reported that cardiovascular disease in childhood with chronic kidney disease on hemodialysis is associated with higher mortality as compared to healthy individuals of same age group.[6] The life-expectancy of children with chronic kidney disease (CKD) on maintenance hemodialysis is very short, with 30-50% of deaths accredited to cardiovascular involvement like arrhythmias, valvular heart disease, congestive cardiac failure, cardiomyopathy (systolic and diastolic dysfunction), left ventricular hypertrophy (LVH), pericardial effusion and vascular calcification.[2,7,9] Hypertension, anaemia, uremia, fluid overload and hyperphosphatemia are the main risk factors contributing to cardiovascular morbidity and mortality.[10]

This study will help identify echocardiographic abnormalities in our children with chronic kidney disease (CKD) on maintenance hemodialysis so that

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timely preventive measures and rectification of risk factors can cause a reduction in morbidity and mortality.

## METHODOLOGY

It was a prospective longitudinal study carried out in the Hemodialysis Unit of the Department of Pediatric Nephrology at The Children's Hospital and Institute of Child Health, Lahore, over six months (Jun 2020 Nov 2020). Our unit is a government-funded tertiary care centre catering to kidney patients all over Punjab. Non-probability, consecutive sampling was used for sample collection. The sample size of 75 cases was estimated by keeping the confidence level at 95%, the margin of error at 11% and the value of LVH at 62% in CKD cases on dialysis.[11]

**Inclusion Criteria:** Children of either gender, aged 6-18 years diagnosed with CKD and on maintenance hemodialysis were included in the study.

**Exclusion Criteria:** Children with pre-existing cardiac disease (congenital and acquired) were excluded from the study.

After ethical approval from the Institutional Review Board (ref no. 2020-146-CHICH), each patient presenting to the Hemodialysis Unit and fulfilling the inclusion criteria was selected for the study. Informed consent was obtained from the parents with the assurance of confidentiality. The children received hemodialysis sessions two/three times per week (2.5-3.0 hours each session) with a 5-7 ml/kg blood flow rate using the F4 dialyzer. Case notes were reviewed for demographic data and a list of medicines. Investigations performed in all patients comprised of complete blood count, renal function test, serum electrolytes (sodium, potassium, calcium, phosphate), serum albumin, iron studies, alkaline phosphatase, vitamin D3, intact parathormone levels and chest x-ray. GFR was calculated by using the Schwartz formula.[11] Adequacy of hemodialysis was determined by urea reduction ratio (URR) and Kt/V where K=dialyzer clearance, the rate at which blood passes through the dialyzer, expressed in millilitres per minute (mL/min), t stands for time, and V is the volume of water a patient's body contains.[12] Transthoracic, two dimensional, M-mode echocardiography was performed in all the subjects with a vivid E95 machine to assess the cardiac morphology and function. M 5S probe was used to calculate ejection fraction through M-mode in parasternal long axis and short axis. The left ventricular ejection fraction (LVEF) was taken to measure left ventricular systolic function. At the same time, diastolic dysfunction was determined by E/A ratio using special Doppler inflow velocity (E is peak early diastolic velocity and A is peak atrial filling velocity of left ventricle across the mitral valve).

Statistical Package for Social Sciences (SPSS) version 20.0 was used for the data analysis. Quantitative variables like age, weight, height, duration of hemodialysis, ejection fraction and laboratory investigations were presented as mean and standard deviation while, qualitative variables like gender, aetiology of chronic kidney disease, route of hemodialysis, anaemia, hypertension and echocardiographic abnormalities were expressed as frequency and percentage.

## RESULTS

Seventy-five children with chronic kidney disease and on maintenance hemodialysis were studied. The aetiology of chronic kidney disease was shown in Figure-I. The most common cases were reflux nephropathy 26 (35%), and the least common were crecenteric glomerulonephritis, Bardet-Biedl syndrome, congenital hypoplastic kidneys and polycystic kidney disease (1%).

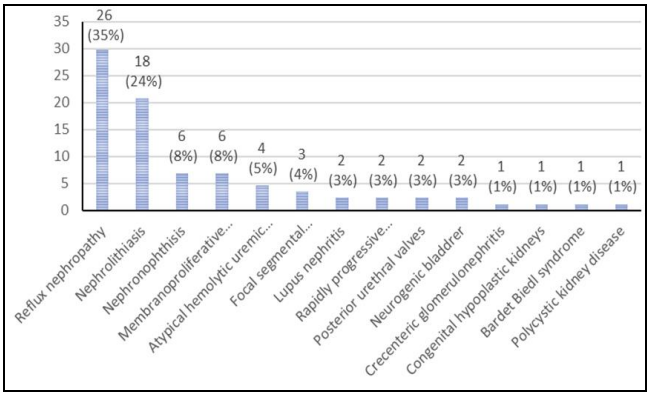


**Figure-I: Etiology of chronic kidney disease.**

The mean urea reduction ratio (URR) (%) was calculated to be 65.58 ± 4.31, and the mean Kt/v was 1.3 ± 0.1. Hypertension was observed in 70 (93.3%) cases, with mean systolic and diastolic blood pressure 134.07 ± 10.64 and 89.13 ± 6.78 mmHg, respectively. The echocardiography revealed left ventricular hypertrophy (LVH), mild systolic and diastolic dysfunction and pericardial effusion. The mean ejection fraction (%) was 58.02 ± 12.40. Echocardiographic findings are shown in Figure-II.

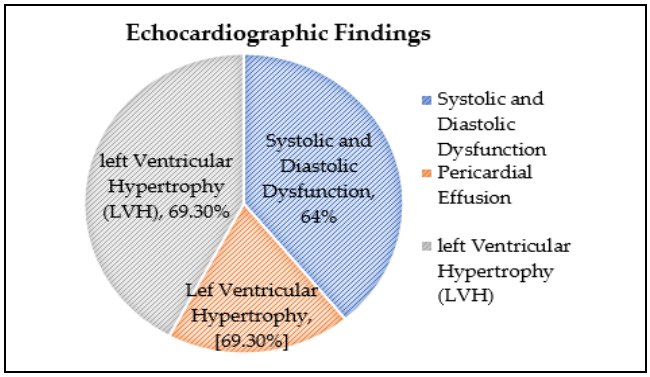


**Figure-II: Echocardiographic findings.**

## DISCUSSION

The burden of cardiovascular disease in children with chronic kidney disease has gained more attention. It has been indorsed that the increase in cardiovascular complications and mortality is high in the paediatric population.[13] The main risk factors in our study were hypertension, anaemia and hyperphosphatemia. Similarly, Rinat *et al*, also observed that volume overload and hypertension resulted in myocardial disease due to cerebrovascular accidents, CCF, cardiac arrest and dissection of the aorta.[14] The echocardiography of our study participants revealed the mean EF of 58.02 ± 12.40%, mild systolic and diastolic dysfunction in 48 (64%) cases and pericardial effusion in 23 (30.7%) cases while 52 (69.3%) patients had LVH. An ejection fraction of >56% was seen despite cardiac abnormalities in a study by Chinali *et al*, consistent with our results.[15] Our results are also similar to the study by Mitsnefes *et al*, who determined the frequency of LVH (30-92%) in patients on hemodialysis and (17-50%) in predialysis patients.[16]

Groothoff *et al*, concluded that cardiovascular diseases are responsible for 41% of deaths in his cohort. Frequency of LVH, aortic valve calcification and stiffening of arterial wall was high.17 Schaefer *et al*, had interpreted the progressive increase in LVH with each CKD stage from 10.6% in CKD stage 3a to 48% in CKD stage 5.18 In contrast, Harambet *et al*, reported a low incidence of LVH (17%) in paediatric cases of CKD with sustained blood pressure (both casual and ambulatory) and 20% with masked systolic or diastolic hypertension.[19] The factors that influence the development of LVH in children with CKD include stage and duration of renal disease, dialysis, type of dialysis, anaemia, serum phosphorus level and blood pressure control.[20,21] Left ventricular ejection fraction (EF) was significantly low after each dialysis session (57.58±6.94 vs 53.64 ± 10.72), showing a significant effect of adequate hemodialysis on cardiac functions in children.[22]

We noticed 64% of subjects with systolic and diastolic dysfunction. At the same time, Chinali *et al*, proposed that the risk of systolic dysfunction was five times higher in children with chronic kidney disease stage 2-4 than normal healthy children when detected by echocardiography.[23] Similarly, significant systolic and diastolic dysfunction in children with CKD on maintenance hemodialysis was observed by Dayon *et al*.[24] An age-related reduction of systolic and diastolic ventricular function was confirmed by Simpson *et al*, who used tissue Doppler imaging for the assessment of cardiac function abnormalities.[25]

## CONCLUSION

As the frequency of LVH was noted to be high in our CKD patients on hemodialysis, there is a need to implement echocardiographic screening of these patients at regular intervals to identify and rectify cardiac complications early.

**Conflict of interest:** None.

**Grant support and funding:** Nill.

**Authors' Contribution**

AA: Principal investigator, NA: Writing of manuscript, AAJ: data analysis, TK: Diagnostic writing, UK: Diagnostic wolkup, AC: Data interpretation.

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