ejpmr, 2022,9(11), 74-80

SJIF Impact Factor 6.222

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

Research Article

ISSN 2394-3211

EJPMR

CARDIOVASCULAR RISK FACTORS ASSESSMENT IN CHILDREN OF CHRONIC KIDNEY DISEASE

Farhana Yasmin*[1], Shireen Afroz[2], Tahmina Ferdous[3], Umme Tanjila[4] and Sukriti Baroi[5]

[1]Registrar, Department of Paediatric Nephrology, Bangladesh Shishu (Children) Hospital and Institute.
[2]Professor and Head of Department of Paediatric Nephrology, Bangladesh Shishu Hospital and Institute.
[3]Registrar, Critical Care Nephrology and Dialysis Unit, Department of Paediatric Nephrology, Bangladesh Shishu (Children) Hospital and Institute.
[4,5]Resident Medical Officer, Critical Care Nephrology and Dialysis Unit, Department of Paediatric Nephrology, Bangladesh Shishu (Children) Hospital and Institute.

***Corresponding Author: Farhana Yasmin**

Registrar, Department of Paediatric Nephrology, Bangladesh Shishu (Children) Hospital and Institute.

Article Received on 07/09/2022 **Article Revised on 28/09/2022** **Article Accepted on 19/10/2022**

ABSTRACT

Background: Patients with Chronic Kidney Disease (CKD) are at significantly increased risk for both morbidity and mortality from cardiovascular disease (CVD). The risk factors thought to be responsible for accelerated CVD in children with CKD are traditional risk factors e.g. hypertension, obesity, sedentary lifestyle and non-traditional risk factors e.g. uremia, anemia, hypocalcemia, hyperphosphatemia, hyperparathyroidism. Determining the spectrum of cardiovascular risk factors in these patients can help in reduction of morbidity and mortality from CKD. **Material and Methods:** This cross-sectional study was held on department of Pediatric Nephrology, Dhaka Shishu Hospital, Dhaka, during July 2018 to December 2018 (Six months). A total of thirty-six children with chronic kidney disease with creatinine clearance <60ml/min/1.73 m^2 and age ranged from 2 to 16 years on supportive treatment and hemodialysis were included. In control group equal number of age and sex matched healthy children without any preexisting renal or cardiovascular diseases were included. Both study group and control group were assessed for cardiovascular findings by echocardiography and study group also assessed for cardiovascular risk factors. **Results:** The mean age was 9.09±3.01 years (mean±SD) in case group and 7.85±3.69 years (mean±SD) in control group. Regarding sex, 22 patients (61.1%) in the case group were male and 14 (38.9%) were female. In this study, in CKD patients significant ($p<0.001$) difference was observed in following cardiac parameters, left ventricular end diastolic diameter (LVEDD) (38.34 vs 34.52), left ventricular end systolic diameter LVESD (26.64 vs 20.75), interventricular septal thickness (IVS) (9.34 vs 7.27), left ventricular posterior wall thickness (LVPWT) (8.36 vs 7.46), ejection fraction (EF) (56.68% vs 70.36%), fractional shortening (FS) (31.88% vs 38.30%) and peak early diastole velocity/peak atrial filling velocity (E/A ratio) (1.15 vs 1.45) when compared to control group. Significantly lower ($p=0.01$) Hb% and significantly higher phosphate and parathormone was observed in CKD children who had abnormal echocardiographic findings. **Conclusion:** Hypertension was a prime traditional risk factor for CVD in CKD children. Amongst non-traditional risk factors anemia, hyperphosphatemia, hyperparathyroidism were noteworthy. Adequate control of hypertension, anemia, hyperphosphatemia and hyperparathyroidism could prevent CVD in children with CKD.

KEYWORDS: Chronic kidney disease, Echocardiography, Risk factors, Child.

INTRODUCTION

Chronic kidney disease (CKD) encompasses a spectrum of different pathophysiologic processes associated with abnormal kidney function and a progressive decline in glomerular filtration rate (GFR).[1] It is an important cause of morbidity and mortality in children worldwide.[1,2] Scientific and technologic improvements during the second half of the 20th century provided renal replacement therapy as a life-sustaining option for many individuals who otherwise may have died.[2,3] In the past 2 decades, the incidence of the chronic kidney disease in children has steadily increased. The Kidney Disease Outcomes Quality Initiative (KDOQI) working group of the National Kidney Foundation (NKF) defined chronic kidney disease as evidence of structural or functional kidney abnormalities (abnormal urinalysis, imaging studies, or histology) that persist for at least 3 months, with or without a decreased glomerular filtration rate (GFR), as defined by a GFR of less than 60 mI/min per 1.73 m^2.[2,3] Patients with CKD are at significantly increased risk for both morbidity and mortality from cardiovascular disease (CVD).[4] Patients on dialysis have a 10 to 30 fold increased risk for cardiovascular mortality compared with the general population. CVD is

the single most important cause of death among patients receiving long-term dialysis, accounting for 44% of overall mortality. Coronary artery disease including myocardial infarction, congestive heart failure (CHF) and pericardial disease are the common manifestations of major cardiovascular abnormalities in the ESRD.[4,5] Heart failure accounts for 15%, myocardial infarction for about 10% and pericarditis for about 3% of dialysis associated mortality. Sudden cardiac death may be related to the high prevalence of left ventricular dysfunction secondary to the LVH in dialysis patients.[7,8] The nature and importance of cardiovascular risk factors in these patients have not been evaluated but may include hypertension, left ventricular pressure or volume overload, anemia, acidosis, hyperparathyroidism, uremia and electrocardiographic abnormalities.[9] The known common cardiac abnormalities in ESRD are increase in LV cavity size, thickened LV posterior wall, thickened interventricular septum, decrease in LV compliance, pericardial effusion and calcific/sclerotic valves.[18,19] Changes in cardiac structure and function detected by echocardiography are common in patients with CKD undergoing hemodialysis, and have been recognized as key outcome predictors.[20,21] This study is intended to find out the cardiovascular risk factors in CKD in children of Bangladesh. This effort was to help target key patient population at risk by quantifying the extent of the problem, and by facilitating an assessment of the impact of intervention.

MATERIALS AND METHOD

It was a cross sectional study done on department of Pediatric Nephrology, Dhaka Shishu Hospital, Dhaka, six months from the day of approval. All children aged 2 to 16 years with chronic kidney disease (GFR<60ml/min/1.73m^2) got treatment from the Department of Pediatric Nephrology of Dhaka Shishu Hospital, Dhaka were enrolled in the study. Equal number of age and sex matched healthy control were also enrolled. The patient or the guardian who refused to participate in the study, children under 2 years and above 16 years of age and GFR ≥60 ml/min/1.73m^2 and known case of any preexisting cardiac diseases were excluded from this study. Patients were approached for participation either in the inpatient or outpatient setting after taking informed written consent. Children with chronic kidney disease getting treatment or follow up, who fulfilled the inclusion criteria were enrolled in the study. Demographic data regarding information about age, relationship of respondent to child, parental education status and socio-economic status were collected from guardian or parents. Medical data regarding diagnosis, treatment status, follow up were obtained from the patient's medical record. Demographic and medical data including biochemical findings regarding risk factors were taken. For checking cardiac status, clinical examination done. Patients with already known cardiac disease were excluded. The purpose of study was explained to all the patients. Echocardiography was done by consultant cardiologist of cardiology department of Dhaka Shishu Hospital. All findings were noted and record was kept. Left ventricular systolic function was taken as LVEF and fractional shortening (FS). E/A ratio showed diastolic dysfunction. E is peak early diastole velocity and A is peak arterial 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 ≥12 mm.

Fractional shortening (s) calculated as
FS (%) = (LVDd-LVDs) x 100 Normal range being 25% to 45%
LVDd: Left ventricle internal diameter in diastole
LVDs: Left ventricle internal diameter in systole
Ejection fraction calculated as
LVEF (%) = (LVVd-LVVs) x 100 Normal= 59.2%±6%
LVVd: Left ventricle volume in diastole
LVVs: Left ventricle volume in systole

The data from patients was collected on a proforma. Data was collected by preformed questionnaires. Data was processed and analyzed by using the SPSS Windows (version 20.0) programs. P value < 0.05 was considered statistically significant. Certificate from the ethical review committee of Dhaka Shishu Hospital, Dhaka was obtained for the study. Written informed consent was taken from the legal guardian of the patient.

RESULTS

This cross sectional study was carried out with an aim to determine the echocardiographic findings and cardiovascular risk factor assessment in different stages of CKD in children in Bangladesh. A total of 36 children age ranged from 2-16 year with chronic kidney disease receiving treatment from Dhaka Shishu Hospital and equal number age and sex matched control were included in this study.

Table I: ***Demographic characteristics of case and control (n=72).***

Characteristics	Case (n=36)		Control (n=36)		P value
	No	%	No	%	
Mean age (years±SD)	9.09±3.01		7.85±3.69		0.122
Range	3-14		3-14		
Sex					
Male	22	61.1	16	44.4	0.157
Female	14	38.9	20	55.6	

Male**:** Female	1.5**:**1		0.8**:**1		
Residence					
Rural	22	61.1	31	86.1	0.031
Urban	12	33.3	3	8.3	
Urban slum	2	5.6	2	5.6	
Socio-economic					
Poor	9	25.0	7	19.4	0.093
Lower middle	17	47.2	26	72.2	
Upper middle	8	22.2	3	8.3	
Father occupation					
Service holder	6	16.7	5	13.9	0.084
Businessman	16	44.4	8	22.2	
Others: (Farmers,Shopkeeper)	14	38.9	23	63.9	
Mother's occupation					
House wife	33	91.7	34	94.4	0.643
Service holder	3	8.3	2	5.6	
Immunized status					
Immunized	22	61.1	25	69.4	0.478
Partially immunized	5	13.9	2	5.6	
Non immunized	9	25.0	9	25.0	

Table II: ***Anthropometry of study patients and control (n=72).***

Anthropometry	**Case (n=36)**		**Control (n=36)**		**P value**
	No	**%**	**No**	**%**	
WAZ					
<3rd percentile	19	52.8	1	2.8	0.001
3rd -50th percentile	11	30.6	13	36.1	
>50th percentile	6	16.7	22	61.1	
HAZ					
<3rd percentile	20	55.6	5	13.9	0.001
3rd -50th percentile	11	30.6	17	47.2	
>50th percentile	5	13.9	14	38.9	
BMI					
Under weight (<18.5)	32	88.9	11	30.6	0.001
Normal (18.5-24.9)	4	11.1	25	69.4	
Overweight (25 -29.9)	0	00	0	00	
>Obese (>30)	0	00	0	00	

P value reached from chi square test

Table III: ***Blood pressure values between case and control (n=72).***

Blood pressure	**Case (n=36)**		**Control (n=36)**		**P value**
	No	**%**	**No**	**%**	
Normotensive	12	33.3	36	100	0.001
Stage 1 HTN	1	2.8	0	00	
Stage 2 HTN	23	63.9	0	00	

P value reached from chi square test

Table IV: ***Hematological & biochemical features of different stages of CKD (n=36).***

Parameters	**Stage 3 Mean±SD**	**Stage 4 Mean±SD**	**Stage 5 Mean±SD**	**P value**
Hb% (g/dl)	11.00±2.12	9.20±1.43	7.34±1.22	0.001
Serum K+	4.50±0.42	4.40±0.27	5.35±0.922	0.074

(mmol/L)				
Serum calcium (mmol/L)	2.10±0.28	2.12±0.22	2.00±0.23	0.554
Serum phosphate (mmol/L)	2.10±0.0	2.12±0.18	2.44±0.40	0.07
Serum PTH (pg/ml)	275.50±62.93	611.00±369.80	845.26±546.59	0.027

Table V: ***Echocardiographic measurement of different cardiovascular parameter between case and control (n=72).***

Parameter	Case (n=36)	Control (n=36)	t value	P value
	Mean±SD	Mean±SD		
LVEDD (mm)	38.34±8.80	34.52±6.56	2.082	0.041
LVESD (mm)	26.64±3.46	20.75±4.84	3.594	0.001
IVS (mm)	11.34±2.08	7.27±1.81	4.502	0.001
LVPWT (mm)	10.36±3.69	7.46±1.61	2.287	0.025
EF (%)	54.68±14.32	70.36±7.69	5.047	0.001
FS (%)	29.88±9.93	38.30±7.58	3.079	0.003
E/A ratio	1.15±0.58	1.45±0.25	2.807	0.007

P value reached from student 't' test

LVEDD: Left Ventricular End Diastolic Diameter
LVESD: Left Ventricular End Systolic Diameter
IVS: Interventricular Septal Thickness
LVPWT: Left Ventricular Posterior Wall Thickness
EF: Ejection Fraction
FS: Fractional Shortening
E: Peak early diastole velocity
A: Peak atrial filling velocity

Table VI: ***Echocardiographic parameters in different stage of CKD (n=36).***

	Stage 3 Mean±SD	Stage 4 Mean±SD	Stage 5 Mean±SD	P value
Left ventricular structure				
LVEDD (mm)	29.50±4.94	34.56±7.14	39.43±8.88	0.204
LVESD (mm)	17.50±3.53	23.13±5.35	27.71±8.73	0.182
IVS (mm)	9.00±1.41	9.42±2.32	10.56±2.07	0.390
LVPWT (mm)	9.50±0.70	9.92±2.07	11.41±1.72	0.866
Systolic function				
FS	41.50±0.70	31.75±3.50	31.26±10.54	0.116
EF	74.00±1.41	63.00±5.88	54.68±14.62	0.381
Diastolic function				
E/A ratio	1.05±0.21	1.17±0.09	1.53±0.61	0.316

P value reached from anova test

Table shows there was no statistically significant difference in left ventricular structure, systolic and diastolic function between stage 3, stage 4 and stage 5.

Table VII: ***Comparison of Echocardiographic findings between case and control (n=72).***

Outcome	Case (n=36)		Control (n=36)	
	No	%	No	%
Left ventricular systolic dysfunction	16	44.4	0	00
Mild pulmonary hypertension	11	30.6	0	00
Left Atrial Dilatation	10	27.8	0	00
Minimum pericardial effusion	3	8.3	0	00

Mitral Regurgitation	4	11.1	0	00
Concentric LVH	2	5.6	0	00
Hypertrophied cardiomyopathy	2	5.6	0	00
Trivial Mitral Regurgitation	2	5.6	2	5.61
Patent foramen ovale (PFO)	3	8.3	0	00

Table VIII: Comparison of risk factors between normal and abnormal echocardiographic findings of case group (n=36).

Parameters	Normal Echo (n=17)		Abnormal Echo (n=19)		Difference between mean	P Value	95% CI
	Mean	SD(±)	Mean	SD(±)			
Hemoglobin	8.4	1.64	7.15	1.31	1.3	0.01	0.27-2.27
Serum Potassium	4.9	1.01	5.4	0.78	- 0.55	0.07	-0.04-1.15
Serum Calcium	2.02	0.26	2.01	0.22	0.007	0.92	-0.15-0.17
Serum Phosphate	2.22	0.34	2.53	0.38	-0.31	0.01	0.06-0.55
Serum PTH	561.88	382.9	989.52	569.59	-427.64	0.01	94.72-760.56

DISCUSSION

This cross sectional study was carried out with an aim to determine the common echocardiographic findings and cardiovascular risk factors assessment in different stages of CKD in children in a tertiary care hospital in Bangladesh as well as their socio demographic parameters. A total of 36 children age ranged from 2-16 year with chronic kidney disease receiving treatment from the Department of Pediatric Nephrology, Dhaka Shishu Hospital and equal number to age and sex matched control were included in this study. The present study findings were discussed and compared with previously published relevant studies.

The present study shows the average age was 9.09±3.01 years (mean±SD) in case group and average age was 7.85±3.69 years (mean±SD) in control group similar to Hafiz I.N. et al[26] where average age 9.88±3.92 years in case vs 10.72±2.88 years in control.

In this study, 22 patients (61.1%) in the case group were male and 14 case (38.9%) were female and ratio was 1.5**:**1. However, this consistent results obtained in other studies, like Harambat et al.[31]

In the present study we found that a statistically significant decrease in Z-score for (weight, height and BMI) in the CKD patients group than control. Our study was in agreement with Hafiz I.N. et al. who found that there were growth deficit in anthropometric parameters in dialysis children compared to healthy control.

In terms of blood pressure, 66.7% of patients in the cases group were hypertensive (P = 0.001), though other studies show a similar prevalence. Mukesh L. et al.[32] found 37.1% cases were hypertensive which was contrary with our results. Many factors contribute to the raised incidence of hypertension in CKD patients. They include sodium retention, increased activity of the renin-angiotensin-aldosterone system, an exaggerated activity of the sympathetic nervous system, secondary hyperparathyroidism, deficient nitric oxide and endothelium-mediated vasodilation. Kale et al.[33] had found that hypertension was identified as important risk factor for all three LV disorder (LVH, diastolic & systolic dysfunction). Systolic, diastolic and mean BP was separately and significantly associated with LV disease. There was no significant difference of hypertension among CKD stages in this study.

In the present study, the CKD Patients were anemic with significant decrease in hemoglobin level. Anemia found in 35 patients (97.2%) in the case group than control (P=0.001), in agreement with our results Mukesh L. et al. who found that CKD patients (patients vs controls) presented with anemia with significant low Hb (9.1 gm/dL vs 12.04 gm/dL) with P value <0.001. In this study there was statistically significant difference in hemoglobin level among different stages of CKD (P = .001). CKD stage 5 children had significantly lower hemoglobin level.

In this study, CKD patients had a left ventricular end diastolic diameter (LVEDD) (38.34 vs 34.52, P = 0.041), left ventricular end systolic diameter LVESD (26.64 vs 20.75, P = 0.001), interventricular septal thickness (IVS) (9.34 vs 7.27, P=0.001), left ventricular posterior wall thickness (LVPWT) (8.36 vs 7.46, P=0.025), ejection fraction (EF) (56.68 vs 70.36, P=0.001), fractional shortening (FS) (31.88 vs 38.30, P=0.003) and peak early diastole velocity/peak atrial filling velocity (E/A ratio) (1.45 vs 1.15, P= 0.007) in comparison to controls. These results are consistent with those obtained by Adiele et al., Malikenas et al.[35] and van Huis et al.[36] Increased LVEDD, LVESD, IVS, LVPWT in comparison to control indicate LVH. In this study 16.6% case had definite Left Ventricular Hypertrophy.

In this study left ventricular systolic dysfunction (44.4%), mild pulmonary hypertension (30.6%), left atrial dilatation (27.8%), minimal pericardial effusion 8.3% was noted in this study to be the most common cardiac abnormality in children and tends to develop early in the disease and cuts across all the stages of CKD. Therefore, the findings of the study are in well

agreement with the findings of the other research works (Adiele et al.).

In this study we found systolic dysfunction in 44.4% cases among them all had low ejection fraction (<59%) and 27.7% had low fractional shortening (<25%).

The analysis of LV diastolic parameters on the basis of E/A ratio was significantly altered in CKD patients as compared to controls, P value in our study is 0.007 in comparison to controls. Left ventricular diastolic dysfunction is an important cause of cardiac morbidity in end stage renal disease. We found 19.4% case had definitive left ventricular diastolic dysfunction. In concordance with our results Schoenmaker[36] et al., 2013 who found that diastolic dysfunction in 20-22% of children on regular hemodialysis but S.Agarwal *et al*[37] had observed diastolic dysfunction in 60% and systolic dysfunction in 15% of patients and its findings were not consistent with our study.

For assessment of definite biochemical risk factors in this study case group was divided in two different group based on their echocardiographic findings. Hemoglobin level was significantly lower (p=0.01) and serum phosphate and serum parathyroid level was significantly higher (p=0.01) in group who had abnormal echocardiographic findings which is similar Neven et al.[68,82] So anemia, hyperphosphatemia and hyperparathyroidism worked as cardiovascular risk factors in case group of this study.

CONCLUSION

Left ventricular systolic dysfunction was the commonest echocardiographic findings in CKD children. Hypertension was a prime traditional risk factor for CVD in CKD children. Amongst non-traditional risk factors anemia, hyperphosphatemia, hyperparathyroidism were noteworthy. Adequate control of hypertension, anemia, hyperphosphatemia and hyperparathyroidism could prevent CVD in children with CKD.

REFERENCE

1. US Renal Data System (USRDS). 2010 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States. Bethesda, Md: National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, 2010.
2. Kopple JD. National kidney foundation K/DOQI clinical practice guidelines for nutrition in chronic renal failure. Am J Kidney Dis., 2001; 37(1,2): S66-70.
3. National Kidney Foundation. K/DOQI clinical practice guidelines for chronic kidney disease: evaluation, classification, and stratification. Am J Kidney Dis., 2002; 39(2,1): S1-266.
4. Wilson AC, Mitsnefes MM Cardiovascular disease in CKD in children: update on risk factors, risk assessment, and management. Am J Kidney Dis., 2009; 54: 345-360.
5. Groothoff JW, Gruppen MP, Offringa M, Hutten J, Lilien MR. Mortality and causes of death of end-stage renal disease in children: a Dutch cohort study. Kidney Int., 2002; 61: 621-629.
6. Chavers BM, Li S, Collins AJ, Herzog CA. Cardiovascular disease in pediatric chronic dialysis patients. Kidney lnt., 2002; 62: 648-653.
7. Krzesinski JM, Sumaili KE, Cohen E. How to tackle the avalanche of chronic kidney disease in sub-Saharan Africa: the situation in the Democratic Republic of Congo as an example. Nephrol Dial Transplant, 2007; 22: 332-335
8. Agarwal SK, Dash SC, Irshad M, Raju S, Singh R, Pandey RM. Prevalence of chronic renal failure in adults in India. Nephrol Dial Transplant, 2005; 20: 1638-42
9. Ardissino G, Dacco V, Testa S Epidemiology of chronic renal failure in children: data from the ItalKid project. Pediatrics, 2003; 111(4 Pt 1): 382-7.
10. Seikaly MG, Ho PL, Emmett L Chronic renal insufficiency in children: the 2001 Annual Report of the NAPRTCS. Pediatr Nephrol, 2003; 18(8): 796-804.
11. Voroneanu L, Covic A. Arrhythmias in hemodialysis patients. J Nephrol, 2009; 22(6): 716—25.
12. Bruch C, Rothenburger M, Gotzmann M, Wichter T, Scheld HH, Breithardt G, et al. Chronic kidney disease in patients with chronic heart failure: impact on intracardiac conduction, diastolic function and prognosis. Int J Cardiol, 2007; 118(3): 375-80.
13. North American Pediatric Renal Transplant Cooperative Study (NAPRTCS) (2005) 2005 annual report. The EMMES Corporation, Rockville, MD.
14. Han P, Singla HK, Mantan M, Kanitkar M, Batra B, Bagga A. Chronic renal failure in children. Indian Pediatr, 2003; 40: 1035-1042.
15. Hamed RMA. The spectrum of chronic renal failure among Jordanian children. J Nephrol, 2002; 15: 130-135.
16. Anochie I, Eke F. Chronic renal failure in children: a report from Port Harcourt, Nigeria (1985—2000). Pediatr Nephrol, 2003; 18: 692-695.
17. Bradley A, Warady, Vimal Chandha. Chronic kidney disease in children: the global perspective. Pediatr Nephrol, 2007; 22: 1999-2009.
18. Van der Heijden BJ, Van Dijk PC, Varrier-Jones K, Jager KJ, Brigs JD. Renal replacement therapy in children: data from 12 registries in Europe. Pediatr Nephrol, 2004; 19: 213-221.
19. Chavers BM, Li S, Collins AJ, Herzog CA. Cardiovascular disease in pediatric chronic dialysis patients. Kidney mt., 2002; 62: 648-653.
20. Mitsnefes M, Ho PL, McEnery PT Hypertension and progression of chronic renal insufficiency in children: a report of the North American Pediatric Renal Transplant Cooperative Study (NAPRTCS). J Am Soc Nephrol, 2003; 14: 2618-2622.
21. Fivush BA, Jabs K, Neu AM Chronic renal

insufficiency in children and adolescents: the 1996 annual report of NAPRTCS. North American Pediatric Renal Transplant Cooperative Study. Pediatr Nephrol, 1998; 12: 328-337.
22. http://www. kidney.org/professionais/kdoqi/guidelines_bp/guide _13.htm acc-essed 13 Dec-05.
23. Foley RN, Parfrey PS, Sarnak MJ. Epidemiology of cardiovascular disease in chronic renal disease. J Am Soc Nephrol, 1998; 9: S16-S23.
24. Manjunath G, Ibrahim H. Level of kidney function as a risk factor for atherosclerotic cardiovascular outcomes in the community. J Am Coil Cardiol, 2003; 41: 47-55.
25. Yap HK, Liu ID, Tay WC. Paediatric Nephrology: On-The-Go Children Kidney center, 2012; 24.
26. Iman. N. Hafez et al AL-Azhar Assiut Medical Journal, January, 2015; 13(1).
27. Benjamin EBS, Frishberg FY. A comprehensive study of cardiovascular risk factors, cardiac function and vascular disease in children with chronic renal failure. Nephrology Dialysis Transplantation, 2010; 25(3): 785–793.
28. Al-Doori TF, El-Salam A, Al-Ethawi D, Hasan JS, Al-Kaaby BA. Towards cardiovascular risks in children with chronic kidney disease: a prospective cohort study. F1000 Research, 2018; 7: 1-15.
29. El-Gamasy MA, Mawlana WH. Risk factors and prevalence of cardiac diseases in Egyptian pediatric patients with end-stage renal disease on regular hemodialysis. Saudi J Kidney Dis Transpl, 2019; 30: 53-61.
30. Mitsnefes MM. Cardiovascular Disease in Children with Chronic Kidney Disease. J Am Soc Nephrol, 2012; 23(4): 578–585.
31. Harambat J, van Stralen KJ, Kim JJ. Epidemiology of chronic kidney disease in children. Pediatr Nephrol, 2012; 27(3): 363–73.
32. Mukesh L et al Journal of the association of physicians of India, January, 2016; 62.
33. Kale SA et al: Left ventricular disorder in patients of end stage renal disease entering hemodialysis programme. Indian J Nephrol, 2001; 11: 12-16.
34. Hüting J. Mitral valve calcification as an index of left ventricular dysfunction in patients with end-stage renal disease on peritoneal dialysis. Chest, 1994; 105: 383-388.
35. Malikenas A, Cerniauskiene V, Jakutovic M, Jankauskiene A. Left ventricular geometry in children with chronic renal failure. Medicina (Kaunas), 2005; 41(1): 5-11.
36. Van Huis M, Schoenmaker NJ, Groothoff JW. Impaired longitudinaldeformation measured by speckle-tracking echocardiography in children with end-stage renal disease. Pediatr Nephrol, 2016; 31(9): 1499–508.
37. S agarwal, P Dangri, OP Kalra, S Rajpal. Echocardiographic assessment of cardiac dysfunction in patients of chronic renal failure. JIACM., 2003; 4: 296.
38. Nashwa MS, Bahia HM, Fatina IF. Prevalence of viral infection among Egyptian children with end stage renal disease. Aust J Basic Appl Sci., 2009; 3: 3479-3491.
39. Buckalew VM Jr, Berg RL, Wang SR. Prevalence of hypertension in 1,795 subjects with chronic renal disease: the modification of diet in renal disease study baseline cohort. Modification of Diet in Renal Disease Study Group. Am J Kidney Dis., 1996; 28(6): 811–21.
40. El-Husseini AA, Sheashaa HA, Hassan NA, El-Demerdash FM, Sobh MA. Echocardiographic changes and risk factors for left ventricular hypertrophy in children and adolescents after renal transplantation. Pediatr Transplant, 2004; 8: 249-254.
41. Neumann J, Ligtenberg G, Klein, II. Sympathetic hyperactivity in chronic kidney disease: pathogenesis, clinical relevance, and treatment. Kidney Int., 2004; 65(5): 1568–76.
42. Passauer J, Pistrosch F, Bussemaker E. Reduced agonist-induced endothelium-dependent vasodilation in uremia is attributable to an impairment of vascular nitric oxide. J Am Soc Nephrol, 2005; 16(4): 959–65.
43. Raine AE, Bedford L, Simpson AW, et al.: Hyperparathyroidism, platelet intracellular free calcium and hypertension in chronic renal failure. Kidney Int., 1993; 43(3): 700–5.
44. Cullis JO: Diagnosis and management of anaemia of chronic disease: current status. Br J Haemato. 2011; 154(3): 289–300.