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Research Paper

Echo-Cardiographic Problems in CKD in Children

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ABSTRACT:

BACKGROUND:

Left -ventricular hypertrophy, Changes in vascular architecture, myo-cardial calcifications are main (structural abnormalities) of the heart that have been described in patients with (chronic kidney disease) and are the most common cause of((mortality)).

OBJECTIVE:

To highlight ((Echo- cardiographic)) findings in children with different stages of chronic kidney disease (CKD) and (risk factors) associated with abnormal echo findings.

PATIENTS AND METHODS:

A ((prospective study)), consist of 50 patients with chronic kidney disease, age ranged between (6 months - 14 years) admitted to ((nephrology- unit)) in children welfare teaching hospital in ((Medical- City complex)) during the period from (1st of Jul. 2019 to 30th of Jul. 2020) were included in the study. Detailed-history was taken, complete -physical examination, biochemical-investigations, Abdominal Ultra-sound, Chest- X Ray and Echo-cardiography- were done to all patients enrolled in the study.

RESULTS:

The study included 29 (58%) male and 21 (42%) female, with (male: female ratio was1.4 : 1), The most common cause of CKD was renal abnormalities 25 (50%) most of them were ((reflux nephropathy and neurogenic bladder)).The most common abnormal Echo findings was (left -ventricular- hypertrophy) in 16 (32 %) of patients. There were no significant association between Echo findings and different stages (III , IV , V) of chronic kidney disease ($p > 0.05$). There were significant association between (((abnormal Echo findings))) and some risk factors like- anemia and hypertension ($p \leq 0.05$).

CONCLUSION:

The most common cause of chronic kidney disease (CKD) was (((congenital renal abnormalities))) in which reflux -nephropathy and neurogenic- bladder is commonest. Echo-cardiogram reveal abnormal finding in 50% of children with CKD, most common abnormal echo finding was left ventricular hypertrophy (LVH). Anemia and hypertension were the most common risk factors that are associated with abnormal echo findings.

KEYWORDS: chronic kidney disease, left ventricular hypertrophy, echocardiography.

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INTRODUCTION:

(Chronic renal failure) term used to describe renal dysfunction of varying degrees from (mild to severe in nature).[1] Recent studies have demonstrated that a(((decrease in glomerular filtration rate))) (GFR) associated with an increase in the cardio-vascular disease events (CVD), hospitalizations, and death from any cause. [2]

Cardio-vascular causes of mortality are different in children than adults with CKD. Left-ventricular hypertrophy, Changes in vascular architecture, myo-cardial calcifications are main (structural abnormalities) of the heart that have been described in patients with (chronic kidney disease) and these are known to cause death in children due to associated (arrhythmia), (associated valvular- disease), and (cardiomyopathy) [3,4]

The way by which cardio-vascular disease develops in children with CKD is remodeling and vascular injury mechanism.

Mechanical or hemodynamic overload of the muscle cause Remodeling of the left ventricle with resulting hypertrophy and subsequent sarcomere changes. The Development of concentric left ventricular

hypertrophy (LVH) is most often secondary to increased resistance from hypertension, while eccentric LVH is often secondary to volume overload or anemia. Over time, worsening LVH changes may lead to decreased subendocardial perfusion with increased risk of arrhythmia generation. [3,5]

Vascular injury may occur, Calcification of vessels, involving the large to medium-sized also been noted to involve the smaller coronary arteries in children with advanced uremia on occasion. [3,6,7]

Cardiovascular disease is main cause of morbidity and mortality in dialysis patients. Structural abnormalities of the heart have been found in patients with CRFincluding LV hypertrophy, Changes in vascular architecture, myocardial calcification.[8]Echocardiography should be performed periodically to find out left ventricular hypertrophy and cardiac dysfunction as a consequence of the complications of CKD. [9]

PATIENTS AND METHODS:

A prospective study, consist of 50 patients with CKD, age 6 mo.-14 yr. admitted to nephrology unit in children welfare teaching hospital in medical city complex during the period from 1st of Jul. 2018 to 30th of Jul. 2019 were included in the study.

Exclusion criteria

Cases bellow 6-month age and above 14 year old.

Cases with congenital heart disease (abnormal echo before getting to CKD).

The following information's were taken from parents and patients files, the questionnaire included the following data:

Demographic characteristic: age and gender.

Causes of CKD.

Stages of CKD (III, IV, V).

Risk factors.

Measurement: height (HT), Ht percentile, weight (Wt), Wt percentile, surface area (S.A), blood pressure (BP).

Investigation: level of blood urea, serum creatinine, S. electrolyte, CBC, lipid profile, S. albumin, HbA1c, GUE, Abdominal US, micturating cystourethrography (MCUG), chest X –ray(CXR), echocardiography (Echo).

Mode of treatment (conservative, peritoneal dialysis, hemodialysis).

Outcome (live, died).

history was taken and physical examination done to patients.GFR is measured in ml/min/1.73m2 by using Schwartz et al. formula (GFR = K x L/PCr L=length, PCr=plasma creatinine K is an empirical constant depending on sex and age of the child),

K=0.33 for low birth wt. infants.

K=0.45 for full term normal size infants.

K=0.55 for girls aged 1-20 yrs. and boys aged 1-13 yrs.

K=0.7 for boys aged 13-20 yrs. [1,10]

Blood Pressure was measured three times during the same day in the sitting position by using a mercury sphygmomanometer and the appropriate-size cuff according to age [11]

The mean of three measurements was calculated.

Hypertension definition is average systolic blood pressure (SBP) and/or diastolic blood pressure (DBP)> 95th percentile for sex, age and height. [12]

Anemia defined as DOQI Anemia Management guidelines recommended when the hemoglobin value is less than 11 g/dl in prepubertal patients with CKD [3, 13].

Pediatric cardiologists have done the echocardiography using GE vivid Ultrasound Machine (GE Healthcare, USA, and Model vivid S6 N), all patients with chronic kidney disease were sent for echocardiography at first 6 months from diagnosis.

Also mode of management of patients (conservative treatment, peritoneal dialysis or hemodialysis) was recorded. Outcome of patients (live, died) during study period were recorded.

Ethical considerations:

The ethical approval was taken from hospital authorities.

Approval was taken from Arab Board medical specialization.

Statistical analysis:

All data were coded and entered to the computer. Data arranged and tabulated by using statistical package for social science (SPSS) software, version 24. Data are presented as frequency and percentage, pie chart and bar chart also used for description of the data.

Suitable tables and graphs were used to describe the data, Associations between different variables were measured by using chi-square and Fisher's exact probability test were used to test qualitative and frequency data and to find any relations between many risk factors and different outcomes. Differences between continuous variables were measured by using analysis of variance (ANOVA test). P value < 0.05 considered to be significant. [1]

Limitation of the study:

Single center experience, longer follow up period needed, small sample size.

RESULTS:

Fifty cases of chronic kidney disease (CKD) were included in the study. There were 29 (58%) males and 21 (42%) females, male: female ratio was1.4: 1 .Congenital renal abnormalities were found in 25 (50%) patients

Of the total patients 25 (50%) were with stage V chronic kidney disease, 13 (26%) and 12 (24%) were stage III and IV respectively as shows in figure (1):

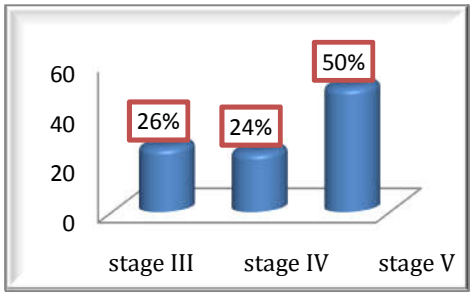

Figure 1: Frequency of stages of chronic kidney disease.

Regarding echo findings of the total 50 patients 25 patients (50%) were having abnormal echo findings, left ventricular hypertrophy (LVH) in 16 (32%) patients Five patients (10%) were with LVH only, 11 (22%) were with LVH and other abnormalities as shown in table (2)

Thirteen patients (26%) had more than one abnormalities in echo, two patients (4%) had dilated cardiomyopathy(DCMP) and 2(4%) patients pericardial effusion, one patient (2%) were having heart failure (HF), 1(2%)primary pulmonary hypertension(PPH), 1(2%) mitral regurgitation (MR) as shown in table (2)

Table 1: Distribution of the patients according their echo findings.

Echo finding	no.	%
Left Ventricular Hypertrophy(LVH)	5	10
HF(heart failure)	1	2
Pericardial effusion(PE)	2	4
PPH(primary pulmonary hypertension)	1	2
MR(mitral regurgitation)	1	2
DCMP(dilated cardiomyopathy)	2	4
LVH& MR &PE	1	2
LVH& PE	2	4
LVH&AR& PE& PPH	1	2
LVH, PPH	2	4
LVH, AR	1	2
LVH, AR, MR	1	2
LVH, MR	3	6
MR, PE	1	2
HF,MR	1	2
Normal	25	50
Total	50	100

Regarding risk factors of CKD in this study, 39 (78%) of patients had anemia, 17 (34%) of patients had hypertension, 5 (10%) of patients had dyslipidemia, and 2 (4%) of patients had diabetes mellitus (DM), the patient may have more than one risk factor, as shows in figure (2).

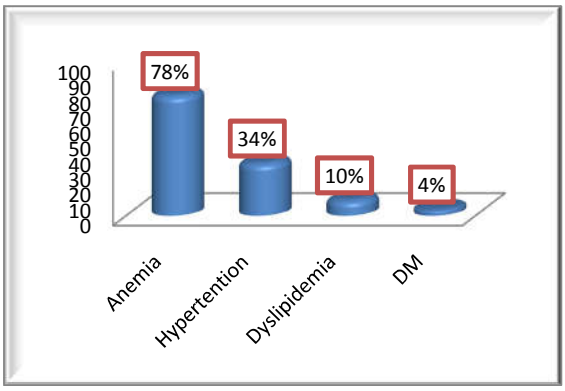

Figure 2: Frequency of risk factors in study sample.

There was no significant association between demographic features and Echo findings as shown in table (2)

Table 2: Relationship between demographic features of the patients and echo finding.

Variables		abnormal echo		normal echo		p value
		no.	%	no.	%	
Age group/year	6 month - 1 yr.	1	16.7	5	83.3	0.05
	1 - 5 years	6	37.5	10	62.5	
	5 – 14 year	18	64.3	10	35.7	
Gender	male	12	41.4	17	58.6	0.1
	female	13	61.9	8	38.1	

There were significant association between abnormal Echo findings and some risk factors, anemia and hypertension ($p \leq 0.05$) patients with history of anemia and hypertension were more prone to develop abnormalities in echo study (cardiac complication), as shows in table (3):

Table 3: Association between echo findings and risks factors.

Risk factors	abnormal echo		normal echo		p value
	no.	%	no.	%	
Anemia	23	59	16	41	0.01
DM	2	100	0	0	0.1
Hypertension	12	70.6	5	29.4	0.03
Dyslipidemia	2	40	3	60	0.6

Table 4: Relationship between echo finding and stages of CKD.

Stage of CKD	abnormal echo		normal echo		p value
	no.	%	no.	%	
stage III	5	38.5	8	61.5	0.1
stage IV	4	33.3	8	66.7	
stage V	16	64	9	36	

There were nosignificant association between Echo findings and stages of CKD as shown in table (4) also no association between echo findings and types of renal replacement therapy in CKD ($p > 0.05$) as shows in table (5):

Table 5: Relationship between echo findings and management of chronic kidney disease.

Type of treatment	abnormal echo		normal echo		p value
	no.	%	no.	%	
Conservative (without dialysis)	8	38.1	13	61.9	0.06
peritoneal dialysis	4	36.4	7	63.6	
Hemodialysis	13	72.2	5	27.8	

DISCUSSION:

Chronic kidney disease was more common in male (58%) in this study, this result similar to that obtained in other studies, (62%) males in Mitsnefes MM et al [14], (58.2%) males in Ali Ahmadzadeh et al [15], and (62% males) in Halle MP et al. studies. [16]The higher prevalence of CKD in males has been attributed to the higher frequency of congenital abnormalities of the kidney and urinary tract (CAKUT) in this group.Current study found that the main cause of chronic kidney disease were congenital renal abnormalities (50%), which was similar to Ali Ahmadzadeh et al. [15] study and Mitsnefes MM et al study [14] were congenital renal abnormalities were most common cause of CKD.

Most of the patients (50%) in the current study were stage (V) chronic kidney disease as these patients referred to children welfare teaching tertiary hospital from other hospitals for renal replacement therapy (hemodialysis or peritoneal dialysis).

This finding was in agreement with study in other studies as Shatha HA et al study [17] the majority were included in stage V (44%), and Halle MP et al study [16] the Stage V was the most frequent (81.3%).

Regarding risk factors of cardiovascular disease (CVD) in chronic kidney disease, 39 (78%) of patients had anemia, this is consistent with results obtained by other researcher(18). A hypo proliferative state is thought to be the underlying mechanism. The latter might result from the following: First, changes in iron metabolism which is hepcidin-induced that causes decreased iron absorption from the gut, in addition to iron macrophage trapping [10,11]. Second, shortened red blood cells (RBC) survival, resulting from raised macrophage activity. Third, a high apoptotic death of RBC precursors in the bone marrow. Finally, a "relative" decline in erythropoietin (EPO) production [11].

17 (34%) of patients had hypertension, which was same to what was found by MITSNEFES M et al study and Wong H et al study. [19]

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, and treatment with erythropoietin–if present[20,21]. In addition, hypertension might be a causative (e.g. hypertensive nephrosclerosis) or contributory pathology in the development of CKD.

In current study, cardiac abnormalities were found in 25 (50%) of the patients with chronic kidney disease, this was higher than what was found by Chavers BM et al study [22] which reported cardiac abnormalities in 24% of all patients, and this could be explained by late referred of patients to nephrologist.

All patients in this study were sent for echo findings 16 (32%) of patients were left ventricular hypertrophy (LVH) is the most common, this finding was in agreement with Doyon A et al [23], Arūnas M et al [24] and Huis MV et al. [25] studies.

Left ventricular hypertrophy (LVH) is regarded by many as an adaptive response to long-lasting volume or pressure overload. Initially, it is beneficial because it allows for increasing work capacity, maintains systolic function and decreases energy consumption & wall stress. However, with time, LVH becomes detrimental as it alters LV diastolic function, decreases coronary perfusion reserve and predisposes to arrhythmias & sudden death [26]. Some researchers [23,24] have found that an increase in LV mass by 1 gm/m2.7/month is associated with a 62% rise in the risk of fatal and non-fatal cardiovascular events in dialysis patients. In our study, all the seven children who died had LVH.

In the present study, there was no statistically significant difference in abnormal echo findings between boys and girls. In addition, there was no statistically significant difference in abnormal echo findings between age groups. These results are also similar to Chavers BM et al [22] and Chinali M et al [26] studies. In current study, there

were no significant association between Echo findings and stages of chronic kidney disease, similar results were obtained by Moustafa B,et al [27] study.

In current study were 13 (72.2%) of patients with chronic kidney disease on hemodialysis had abnormal echo finding which is similar to McIntyre C .et. al. [28] study.

In contrast to current study, Doyon A et al [23] study reported high prevalence of left ventricular hypertrophy (LVH), which increased with declining renal function and was highest in hemodialysis patients, Maria Chiara et al [29] study observed that not only children receiving chronic dialysis, but also children with mild or moderate Chronic renal insufficiency (CRI) had abnormal diastolic function of the left ventricle.

CONCLUSIONS AND RECOMMENDATIONS:

The most common cause of chronic kidney disease (CKD) was congenital renal abnormalities. Abnormal echo cardiogram was found in 50% of children with CKD, LVH was most common abnormality. Anemia and hypertension found as a common risk factors that are associated with abnormal echo findings.

We recommend regular assessment of all CKD patients with echocardiography also continuous monitoring of risk factors with Close cooperation between cardiologists and nephrologists is needed.

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