Influence of Left Ventricular Mass Indexation Criteria in the Diagnosis of Left Ventricular Hypertrophy by Echocardiogram. Study in Children with Chronic Renal Disease

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Abstract

Background: **the echocardiographic diagnosis of left ventricular hypertrophy (LVH) in children is based on the indexed left ventricle mass calculation. However, the indexation criterion is still not defined.**

Objective: **to compare different criteria used for the diagnosis of LVH by echocardiography in children.**

Method: **The study included children with chronic renal disease (CRD) in dialysis (DI) or in conservative treatment (CT). Measures for left ventricle mass calculation were obtained as recommended. The criteria used for LVH were: 1) mass (g) – LVH according to gender and body surface area (BSA, m^2) – based on large study of normal Brazilian children; 2) mass indexed to body surface area (g/m^2) – LVH according to gender and body surface area (BSA, m^2) – based on large study of normal Brazilian children; 3) $g/altura^{2,7}$ but diagnosis of LVH by a nomogram of age, gender and height; 4) z score (http://parameterz.blogspot.com/2008/09/lv-mass-z-scores) – LVH if > 2 standard-deviation. The proportion of LVH among the groups were compared by X^2; significant if $p < 0.05$.**

Results: **60 children with CKD were included; 34 in DI (17 boys; median of age= 109 months) and 26 in CT (15 boys; median of age= 80 months). According to each criteria, in the hole group, the proportions of LVH were, respectively, 31/60, 33/60, 41/60 e 31/60 (p=0.049), lower for criterion 2 compared to 3 (p=0.026); in DI group were 23/34; 23/34; 31/34 e 29/34 (p=0.006), higher with criterion 3 compared to criteria 1 (p=0.033) and 2 (p=0.004), and with 4 compared to 2 (p=0.029); in TC group were 8/26; 10/26; 10/26 e 2/26 (p=0.038), lower for criterion 4 compared to criteria 2 (p=0.038) and 3 (p=0.009).**

Conclusion: **in children with CKD the proportion of LVH by echocardiography was different according to the criterion used. (Arq Bras Cardiol: Imagem cardiovasc. 2016;29(2):42-46)**

Keywords: **Echocardiography/methods; Child; Left Ventricular Hypertrophy; Chronic Renal Failure; Renal Dialysis.**

Introduction

Echocardiography is used to diagnose and assess the impact of various cardiac or systemic diseases. Left ventricular mass, whether indexed or not, is the measure most used for the diagnosis of left ventricular hypertrophy (LVH) by echocardiography in adults and children.[1,2] Chronic kidney disease (CKD) may induce major changes in the left ventricular structure and function. LVH is common in children with CKD and is related to the more advanced forms of the disease and hypertension, and increases the risk of cardiovascular events.[3-6]

Left ventricular mass is most often based on measurements of left ventricular diameter, ventricular septal thickness and posterior wall thickness.[2,7] In children and adults, the dimensions of the cardiac structures are related to body size, but other factors such as race, genetic and gender characteristics can influence the variables used to calculate left ventricular mass.[1,8,9] Indexation based on some measurement of body size is important in clinical studies to compare children of different sizes and analyze the effects of the disease and the therapeutic measures implanted, but also in clinical practice. The criteria most often used for ventricular mass indexation is body surface area, height or height to the power of 2.7.[1,2,6,8,10,11] In recent years, percentile curves or z score have been used to express different echocardiographic measurements in children, including LV mass and, considering the results, they have been recommended as the most appropriate forms.[1,12] In children, the 95th percentile depends on age, gender and height, while the z score reflects the number of standard deviations that the measure obtained is from the average; in the case of left ventricular mass, up to $z = 2$ is considered normal. It has the advantage of not considering the relationship between the variable and the criterion used as an indexer. The values are determined from normal individuals for different body sizes.

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Based on these considerations, the purpose of this study was to compare the proportion of LVH diagnoses by four mass indexation criteria in children with different degrees of CKD.

Methods

Patients: children with CKD on dialysis (DI) or conservative treatment (CT) receiving specialist treatment in pediatric nephrology were sequentially included, and a control group (CG) composed of healthy children matched for age and sex in relation to those with CKD. To enroll in the study, the children should be aged under 14, be authorized by their legal guardians to participate in the study and hold a proper echocardiographic image. This study has been approved by the Research Ethics Committee and the parents or legal guardians of the children who accepted to participate in the study signed an informed consent form.

Clinical aspects and anthropometric measurements: we evaluated the clinical and laboratory data (plasma creatinine and creatinine clearance) in relation to the CKD classification.[13] The following data were obtained: age (in months), sex, weight (kg), height (cm) and the body surface area (m^2) was calculated by the formula of Dubois & Dubois.[14] Blood pressure was also measured as recommended.[15]

Echocardiogram: this was carried out with the children in the supine position or on their left side by a single pediatric cardiologist (VTS) using the system Philips HDI 5000 CV (Bothell, WA, USA, 2000) and transducer with appropriate frequency for body size. Sedation was used when necessary. In children on dialysis, the test was carried out between 4 and 24 hours after dialysis; on the others, including the control group, after clinical consultation. The images were obtained through simultaneous echocardiography and recorded on videotape for later analysis. The final value of each measurement was the average of the three cardiac cycle measurements. To perform the measurements, diastole was defined as the onset of the QRS complex, and systole was defined as the peak of the T wave of simultaneous electrocardiography.

Linear left ventricular (LV) echocardiographic measurements were performed in M-mode with the positioning of the line guided by the two-dimensional image in the longitudinal or transverse parasternal sections. In children on whom it was not possible to position the M-mode line perpendicular to the long axis of the cavity, the measurements were obtained directly from the two-dimensional image. The LV mass was calculated as recommended by the American Society of Echocardiography.[1,2] The LVH criteria were: 1) mass in grams compared to the respective values for the sex and body surface area (m^2);[11]2) mass in grams indexed to body surface area (g/m^2) compared to the respective values for gender and body surface area (m^2);[11]3) g/height^{2,7} with diagnosis of LVH performed as per nomogram that includes age, sex and height;[10]4) z score (http://parameterz.blogspot.com/2008/09/lv-mass-z-scores – LVH if > 2 standard-deviations).[16]

Statistical analysis: the values weare presented as mean and standard deviation. The differences of variables between groups were analyzed by nonparametric Wilcoxon test. The proportions of LVH by the criteria were compared by chi-square test (x^2). Concordance analysis was also performed between the four methods for diagnosing LVH. A significance level of 5% was considered for all tests.

Results

Patients: 60 children were included in the study; 34 were in the DI group and 26 in the CT group. Among the groups, there was no significant difference in relation to sex, age, weight, height and heart rate of children at time of echocardiography; systolic and diastolic blood pressure was higher in the DI group compared to CT (Table 1).

Echocardiography: four children needed sedation with chloral hydrate. The measurements were obtained by two-dimensional image in only two children. Diastolic diameter, diastolic thickness of interventricular septum and posterior wall, left ventricular mass in absolute value, the mass indexed by body surface area and height to the power of 2.7 were higher in the DI group compared to the CT group (Table 2); the median z score in the DI group was higher than in the CT group (Table 2). In the total group and in the DI and CT groups there was no significant difference in the proportion of LVH (Table 3). The total group of patients, the proportion of LVH diagnoses was significantly smaller by the 2 criterion compared to 3 ($p = 0.026$) (Table 3). In the CT group, the criterion 4 (z score) identified less LVH

Table 1 – Distribution of sex and median (interquartile ranges) of anthropometric and clinical characteristics of patients and comparison in each group

Group	N	B	Age (months)	Weight (kg)	Height (m)	SBP	DBP	HR
DI	34	17	109 (44-144)	22 (12-28)	123 (89-134)	135* (115-143)	84* (70-100)	95 (82-110)
CT	26	15	80 (27-153)	19 (9-29)	115 (75-144)	112 (105-123)	68 (55-76)	93 (78-100)
Total	60	32	93 (34-147)	20 (11-28)	115 (86-135)	126 (110-138)	76 (62-83)	94 (79-104)

**(Wilcoxon test) DI greater than CT — SBP: p = 0.0018; DBP: p = 0.0008; DI: dialysis group; HR: heart rate; B: boys; N: number of patients; SBP/DBP: systolic and diastolic blood pressure (mmHg); CT: group under conservative treatment.*

Table 2 – Median of the echocardiographic variables studied

Group	LVDd (mm)	IVS (mm)	LVPW (mm)	Mass (g)	LVMI (g/m^2)	Mass/height^{2,7}	z score
DI	38 (31-43)	8.8 (7-10)	8.4 (7-10)	99 (59-135)	118 (88-133)	66 (45-85)	2.35 (1.05-2.9)
CT	28* (25-37)	7.2* (5.3-8.9)	6.8* (5-8)	41* (25-92)	64* (42-107)	44* (31-56)	-0.9 (-1.6-0.6)
Total	35 (27-40)	8 (6-10)	8 (6-9)	80 (35-129)	98 (68-123)	53 (41-72)	1 (-0.5-2.4)

**: significant difference between DI and CT (Wilcoxon; p < 0.01 for all); LVDd: left ventricular diastolic diameter; DI: dialysis group; LVMI: left ventricular mass index; LVPW: left ventricular posterior wall thickness; IVS: interventricular septum; CT: group under conservative treatment.*

Table 3 – Left ventricular hypertrophy diagnosis ratio in each group according to the diagnostic criterion used

Criterion	Diagnostic criterion	DI group	CT group	Total
1	Mass (g)	23/34	8/26	31/60
2	LVIM (g/m^{2,7})	23/34	10/26	29/60
3	Nomogram	31/34	10/26	42/60
4	z score	29/34	2/26	31/60
P		0.006	0.038	0.049

DI: dialysis; LVIM: left ventricular index mass; CT: conservative treatment; p: comparison between criteria in each group.

in relation to the criteria 2 (p = 0.038) and 3 (p = 0.009). In the DI group, criterion 3 identified more LVH than criteria 1 (p = 0.033) and 2 (p = 0.004) and the criterion 4 more than criterion 2 (p = 0.029) (Table 3).

Discussion

This study involving children at different stages of chronic kidney disease suggests that there may be variation in the prevalence of diagnosis of left ventricular hypertrophy on echocardiography according to the criterion used.

Analyzing the total number of children with CKD in this study, which includes those under dialysis and those still under conservative treatment, it is perceived that the identification of LVH by criterion 2 was inferior only in relation to criterion 3, with no significant difference among the other criteria. Although small, the difference was significant.

In the CT group, criterion 4 (z score) identified less LVH than criteria 2 and 3. Children with CKD under CT are less likely to have their heart adversely affected by the disease, considering the significant difference in blood pressure, significantly lower values of diastolic diameter and left ventricular myocardial thickness, and, consequently, lower LV mass values. This may suggest that the z score would have lower sensitivity than the other criteria for the diagnosis of left ventricular hypertrophy in patients with lower pretest chance of left ventricular hypertrophy. It is worth considering, however, that this study was not designed to analyze the sensitivity of diagnostic criteria.

On the other hand, in the DI group, composed of children with more advanced CKD and possibly greater cardiac involvement, criterion 3, in particular, and 4, identified more LVH than criteria 1 and 2. High blood pressure and dialysis are important factors in cardiovascular and LVH impairment in children with CKD and were the main characteristics in the DI group.[3-6]

Criteria 1 and 2 derived from a study that included 595 healthy children in the state of São Paulo, including boys (326) and girls.[11] The children in this study had a body surface area ranging from 0.20 to 1.53 m^2. This allowed the authors to classify the dimensions of some cardiac structures on echocardiography and some parameters calculated, such as left ventricular mass according to sex and body surface area. The absolute value of LV mass is not usually used as a criterion for the diagnosis of LVH, but is analyzed for body surface area ranges, it may be a possibility. Criterion 2, also deriving from the same study, is the conventional mass index with correction for body surface area (g/m^2), more recommended in adults,[2] but can also be used in children.

To calculate the z score used in this study, the diastolic thickness of the septum and posterior wall and the left ventricular diastolic diameter, as well as sex, age and height, were entered. These parameters are the same ones used for criterion 3, that is, mass indexed by the height to the power of 2.7, which has a nomogram as reference values that identified a greater proportion of left ventricular hypertrophy in children with CKD under conservative treatment than the z score. These two criteria identified a higher proportion of ventricular hypertrophy in the group on dialysis. Another study also observed a difference in LVH proportions with different criteria.[17]

The z score is quite attractive as a concept and application and has been used by many echocardiography laboratories around the world to detect abnormalities of various parameters.[1,16] The use of this criterion for the diagnosis of

LVH in children with CKD in our community requires caution and further analysis should be made to check the accuracy and the potential differences of using a criterion whose reference values derive from children from other countries. The same comment applies to the criterion 3, despite the performance in this study.

Some limitations of this study should be considered. The total number of children is still relatively small but has the advantage of including children with CKD of different severity and varied cardiac involvement. In this study, we did not have a reference standard that could help identify which of the criteria has greater sensitivity, specificity and accuracy for the diagnosis of left ventricular hypertrophy; that was not the purpose of the study. Not only the children's size (height and weight) appears to influence cardiac dimensions. Recent meta-analysis in adults aged over 18 years showed that reference values of linear measurements and ventricular volumes may differ according to the ethnic origin of people.[9] This has not been considered in this study. The data from this study derived primarily from children with CKD. The extension of these findings for other groups of children with diseases that may cause LVH should be done carefully, particularly in cardiac malformations involving the left ventricle.

Despite some limitations, it can be concluded that the proportion of LVH in children with CKD may vary depending on the echocardiographic criterion used. Further studies are needed to determine the most appropriate criteria for echocardiographic diagnosis of LVH in children.

Authors' contributions

Research creation and design: Moises VA; Data acquisition: Di Napoli PCF, Saqueti E, Trigueiro C, Oporto V, Scavarda VT; Data analysis and interpretation: Di Napoli PCF, Saqueti E, Moises VA; Statistical analysis: Scavarda VT, Moises VA; Manuscript drafting: Di Napoli PCF, Saqueti E, Scavarda VT, Moises VA; Critical revision of the manuscript for important intellectual content: Silva CMC, Diógenes MS, Campos O.

Potential Conflicts of Interest

There are no relevant conflicts of interest.

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Academic Association

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