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Review article

Echocardiographic evaluation of cardiac structure and function in children with hypertension

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ABSTRACT

Arterial hypertension is the leading cause of morbidity and mortality in adult population. In recent years, the prevalence of hypertension in children has been increasing, mainly due to increased prevalence of obesity. Similar to adult population, arterial hypertension can also manifest with target organ damage such as left ventricular hypertrophy (LVH), increased arterial stiffness, microalbuminuria, brain damage or retinopathy in children and adolescents. Therefore, for diagnostic and therapeutic reasons, echocardiography is recommended as a primary tool for evaluating patients for target-organ abnormalities by assessing the presence or absence of LVH. The ESH hypertension management guideline 2009 for children recommends evaluating the left ventricular mass and microalbuminuria regularly in this case. Echocardiography is a non-invasive fundamental visualization method which has the ability to evaluate heart morphology and function in detail and to assess the progression or regression of hypertrophy. Thus, it is frequently used in children with hypertension. Even though it is easy to perform echocardiography, it is more complicated to assess left ventricular mass in children as this assessment depends on age. The objective of the publication is to review left ventricle parameters evaluation in children (left ventricular mass, LVM, left ventricular mass index, LVMI), particularly in diseases which may lead to higher cardiovascular risk as early as childhood or early adulthood.

Contents

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Introduction

Echocardiography (ECHO) is the basic non-invasive imaging method in paediatric cardiology, which is capable of detailed assessment of heart morphology and function, employing a variety of methods (2D (two-dimensional) imaging, M-mode, colour Doppler mapping and measurement of blood flow velocity, tissue Doppler imaging, stress test and contrast examination, three-dimensional imaging).

Echocardiography does not stress the patient, it is repeatable, well reproducible and repeated measurements allow the dynamics of monitored parameters to be compared and assessed. In paediatric cardiology, echocardiography is used particularly in prenatal and postnatal diagnoses of congenital heart defects and their follow-up monitoring (defects without surgery, after radical or palliative correction). However, heart structure and function are also monitored in children with arrhythmia, infection or inflammation of the heart, cardiomyopathy and in the case of functional disorders (chest pain, tendency to collapse) as well as hypertension.

Arterial hypertension is the most common cardiovascular disease of adult age; however, with the expansion of routine blood pressure measurement in paediatrics and increasing prevalence of obesity in children [1], it is also becoming a paediatric issue. It has multifactorial etiopathogenesis and may lead to target organ damage (TOD), such as left ventricular hypertrophy (heart), increased pulse wave velocity (i.e. proof of increased vascular rigidity), microalbuminuria (kidney damage), and retinopathy (eye), even in children. Therefore, echocardiography is becoming increasingly used in arterial hypertension evaluation by monitoring the development of the left ventricular hypertrophy (LVH) and its remodelling and in determining its mass. This monitoring is used in childhood [1,2] and especially in adulthood [3] in stratification, i.e. the determination of cardiovascular risk, and helps in determining therapeutic strategy. Paediatric research about the effects of antihypertensive treatment on cardiac end-organ damage is limited, nevertheless, some data suggest that effective antihypertensive treatment may ameliorate cardiac geometry in children [2].

LVH is an adjustment mechanism to chronic pressure overload in arterial hypertension, which allows the left ventricle to maintain volume output against the increased systolic pressure. The hypertrophy is a risk factor for morbidity and mortality in hypertension – the presence of LVH worsens the prognosis in hypertensive patients. Moreover, hypertrophy and geometry of the left ventricle may stratify the risks in arterial hypertension patients independently and better than blood pressure and other risk factors. Adult patients with LVH have a significantly greater incidence of cardiovascular complications (heart failure, acceleration of coronary atherosclerosis, myocardial infarction, renal failure) [4]. Studies conducted so far have shown a strong, continuous and independent relationship between left ventricular mass and subsequent cardiovascular morbidity [5]. Similar to microalbuminuria, increased pulse wave velocity, vascular wall hypertrophy, and sclerotic plaques, the presence of LVH in hypertensive adult patients must be comprehensively examined and may lead to early and intensive antihypertensive treatment [6].

Although the risk of myocardial damage or substantial alteration of cardiac function in children is low, it is possible to diagnose and monitor heart muscle hypertrophy at this age [1,2]. The occurrence of LVH is more common especially in children with hypertension, and rises with increasing weight and the BMI of [7,8]. Recent studies have shown that up to 40% of children diagnosed with hypertension have the left ventricular mass (LVM) above the 95th percentile [9]. In children with primary hypertension, LVH has probably the strongest relationship to the daily variability of systolic blood pressure and nocturnal systolic pressure load [10]. However, LVH also depends on other factors (age, gender, height, growth factors, insulin resistance, etc.) [11]. Reduction in obesity and decrease in insulin resistance are the most important factors for the normalization of left ventricular geometry [11]. It examines the relationship between the genetic predisposition to the development of LVH in hypertensive parents' children before the development of a hypertensive disease. LVH can also have physiological nature in young sportsmen (adaptation mechanism), but in this case there is a risk of transition to pathological hypertrophy. In addition to comprehensive cardiological examination and the determination of left ventricle parameters, children with hypertension and diseases affecting the cardiovascular system (e.g. chronic renal disease) must also be monitored for systolic and diastolic heart function. LVH and myocardial dysfunction are important independent factors of cardiovascular risk in the case of chronic kidney disease [11] and after kidney transplantation [12] and children with chronic kidney disease even after kidney transplantation are in the highest risk of premature cardiac disease and death [13,14]. Similarly, children with diabetes Type 1, homozygous familial hypercholesterolaemia, after orthotopic heart transplantation, and Kawasaki disease with current coronary artery aneurysms were included in the same high risk group [14].

The left ventricle parameters can be also examined using other imaging methods (X-ray, CT, NMR); however, due to its availability, relative ease, speed and non-invasive nature, echocardiography remained the method of choice, particularly in children, and echocardiography examination is indicated for all hypertensive children, especially those with kidney disease, type 1 diabetes mellitus and obesity. If repeated measurements find hypertrophy or a change in the dynamics

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