



Investigation of pediatric innocent murmur with echocardiography

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Received: 22.04.2022

Accepted/Published Online: 16.07.2022

Final Version: 29.10.2022

Abstract

Innocent murmurs are common in childhood. Usually, they are heard without any structural and physiological abnormalities. The murmur is usually weak and short. But even if it is thought to be innocent, echocardiography (ECHO) is occasionally requested by primary doctor or families. The aim of this study is evaluation of childhood innocent murmur with ECHO and possible minor findings with normal clinical status. This is a descriptive - retrospective chart review. We reviewed the charts of children and adolescents who were referred with asymptomatic murmur to Pediatric cardiology clinic at Fatih University Hospital between 01/ 2010 – 12/2011. Any type of congenital/acquired cardiac diseases are excluded. We only included first to third degrees of murmurs. All participants are analyzed based on demographic, clinical, and ECHO finding data. It was reviewed 610 charts, 82% (495) of the chart were included to study. 209 (42.2%) of cases were female. Minimal Tricuspid valve regurgitation (TVR) was seen in 200 children (40.4%) and minimal TVR+ physiological Mitral valve regurgitation (MVR) was seen in 65 children (11.6%). Patent foramen ovale (PFO) was seen in 306 children (54,8%). Left ventricular (LV) muscular band (false tendon) was seen in 171 children (30,6%). Minimal TVR + physiological MVR+ LV muscular band (false tendon) was seen in 26 children (4,7%), trivial arteria valve regurgitation (AVR) was seen in 7 children (1,4%), and minimal TVR + minimal pulmonary regurgitation (PR) was seen in 11 cases (2%). ECHO evaluation is common to use to rule out pathological murmur. Included cases exhibited some cardiac findings but none of those cause any shown cardiac dysfunction in near future. We advise innocent murmur group to be followed by primary physician unless they have any cardiac symptoms

Keywords: innocent murmur, murmurs, echocardiography, pediatric cardiology

1. Introduction

Innocent heart murmurs (IHMs) are accepted as functional and harmless with the absence of any anatomical or physiological cardiac pathology (1). 50-90% of murmurs that are observed between 3 to 7 years of age are innocent. There is no reported difference between genders and races (2-4). Definition of innocent murmur is that the murmur is heard during the systole or continuous and intensity rises to a maximum of 3 degrees without trills. Both innocent and pathologic murmurs become more intense with increased cardiac output, such as anemia, fever, exercise, acute anxiety, and acute illness (1).

ECHO is accepted as the gold standard to evaluate murmurs in children and more sensitive than physical exam. With the increased accessibility to ECHO, all children who have murmur should be evaluated by a cardiologist with ECHO (5).

For that reason, we retrospectively evaluated medical records of children who were referred for IHM and underwent ECHO imaging.

2. Material and Methods

This is a single centered retrospective chart review. All demographic, clinical, laboratory data were extracted from patient medical records of patients between 1-17 years old, who were referred to Pediatric Cardiology clinic due to first time evaluation of murmur. The study was approved by Institutional Research Board (IRB). The ethical approval for this study was obtained from Fatih University Faculty of Medicine Ethics Committee (approval number: 2008-15).

Patients who were on medication or who had history of prematurity, NICU admission, cardiac or other chronic diseases or positive family history of cardiac diseases were excluded. All anthropometric measurements with vital sign records are investigated. Patients who have less than 3rd percentile or more than 97th percentile or abnormal vital signs were excluded from study.

Patients who have been clinically diagnosed with pathological murmur after detailed physical examination were

also excluded.

Philips Envisor® was used for Echocardiographic (ECHO) investigations. All patients were evaluated in supine and left lateral positions with 2-6 MHz of ultrasound transducers. All measurements were gathered in M-mode and assessed with respect to the recommended normal values by the American Society of Echocardiography (ASE) (6-9). Left ventricular systolic function was calculated by the machine with fractional shortening and ejection fraction. Atrioventricular (mitral and tricuspid) and ventriculoarterial (pulmonic and aortic) valves mean gradient measurements were gathered by Doppler ECHO. Patients who have a significant gradient impedance that was more than 1 cm by the valve coaptation point on any valves were excluded.

All statistical analysis was done in SPSS for Windows 16th edition (SPSS Inc, Chicago, Illinois, USA). T-test was used to compare the mean of continuous variables, and Chi-square is used to compare categorical data. P-value <0.05 is accepted as significant.

3. Results

Electronic medical record system screened with “ECHO” and “innocent murmur” words. Based on screening, 610 charts were reviewed, and 495 of them were included in the study. 115 patients excluded due to having one of these exclusion criteria: history of prematurity, NICU admission, cardiac or other chronic disease or being on medication or positive family history of cardiac diseases, less than 3rd percentile or more than 97th percentile or abnormal vital signs, physical examination concluded with pathological murmur. Table 1 shows the characteristics of the study population.

Table 1. Characteristics of study population

Characteristics of patients	
Age, months, mean (SD)	52.2 (±41.9)
Gender, male, number (%)	286 (57.8)
Degree of murmur, number (%)	
- First degree	78 (15.8)
- Second degree	408 (82.4)
- Third degree	9 (1.8)
Type of murmur:	
- Midsystolic	487 (98.4)
- Pansystolic	8 (1.6)
Extra heard sounds, number (%)	3 (0.6) *

*A patient was with S3 and 2 patients were with midsystolic click

Based on physical examination notes that were completed by a cardiologist, 98.4% of innocent murmur was defined as midsystolic and 1.6% of them was pansystolic. Only 0.6% of patients had extra heart sounds like S3 and midsystolic click. 98.2% of murmur was first- and second-degree strength.

Only 6.8% (34/495) of cases were evaluated with electrocardiography (EKG) due to being clinically normal and having normal rhythm. There was no significant rhythm abnormality in EKGs and all EKGs were reported as within normal limit for age. All cases were evaluated by CBC. Based on the records, none of the participants had anemia or

cytopenia. ECHO findings are listed in table 2.

Table 2. ECHO findings

ECHO findings	(n)	(%)
Minimal tricuspid regurgitation (TR)	200	40,4
Physiologic Mitral regurgitation (MR)	2	0,4
Left ventricular aberrant band (LVAB)	9	1,6
Pulmonary artery turbulent flow (PATF)	3	0,5
PATF+ Minimal TR	8	1,4
Minimal TR+ Physiologic MR	65	11,6
LVAB+ PATF	1	0,2
LVAB+ Minimal TR	128	22,9
Minimal TR+ minimal ductus flow	13	2,2
Minimal TR+ physiologic MR+ LVAB	26	4,7
Minimal TR+ Minimal pulmonary regurgitation (PR)	11	2
Physiologic MR+LVAB	2	0,4
Minimal TR+ Physiologic MR+ Trivial aorta regurgitation (AR)	11	2
Minimal TR+ Trivial AI	3	0,5
Minimal TR+ Minimal PR+ LVAB	3	0,5
Trivial AR+ Physiologic MR+ LVAB	2	0,4
Transient narrowing in neonates.	1	0,2
Minimal TR+ Physiologic MR+ trivial AR	2	0,4

In doppler analysis, 85.8% of cases were found with minimal (clinically insignificant) TVR. 45.4% of those had additional pathological findings like PVR (1.6%), MVR (15.7%), and AVR (3.4%).

Left ventricular muscular bands (false tendons) (LVMB) is seen in 30.6% of cases. All LVMBs were longitudinal. Additional clinically insignificant findings like TVR was contributing to 70.8% of LVMB cases.

Patent foramen ovale (PFO) was seen in 54% of cases by itself or with other insignificant findings. It was observed more commonly in males than females (F:0.69 x M).

When we looked at the overall insignificant minimal positive findings, all minimal pathologies were seen in patients under five years old ($p < 0.01$) and there was no significant difference by gender ($p > 0.05$).

4. Discussion

Murmurs constitute approximately 70% of pediatric cardiology consultations. Many opinions have been put forward regarding the formation mechanisms of murmurs. Various methods are used to understand whether murmurs are pathological or innocent. Innocent murmurs are murmurs that are common in childhood for which normal values are observed as a result of examinations for the murmur etiology.

The frequency of innocent murmur is reported to be 50-90% in the literature (3). In the study conducted by Fogel in the 1960s, the frequency of innocent murmur was found to be 63% in the childhood population (10). Castellotti et al. reported innocent murmur rate 41% in 256 children who were admitted due to murmur (11). Similar studies were conducted in various regions of Turkey. Üner et al. showed that the murmur frequency is 4% in school age children and 86% of them (3.7% of all study population) were innocent (12). Kozan et al., reported this rate as 10%, and it was emphasized that the low

result compared to the literature was that the study was conducted in a tertiary hospital and the applications were generally referred for pathological reasons (13). Congenital heart disease (CHD) in children was found between 0.8-1% in the literature (2). In studies conducted with all school-age children in Turkey, the rate of CHD was 0.21% for Şanlıurfa province (Koç et al.), and 1% for Elazığ province (Aygün et al.), 0.14% for Adana province (Altıntaş et al.), and 0.44% and 0.2% for Diyarbakır province (Elevli et al. and Yıldırım et al.), respectively (14-18). Children with CHD or other rheumatic heart diseases on ECHO were excluded from our study.

The character of innocent murmurs depends on postural changes and Valsalva maneuver (3, 19). However, innocent murmurs as defined by Bronzetti et al. are systolic, short, soft, inaudible in all areas, not accompanied by click or additional sounds, are not noisy, and their characteristics do not change with respiration and/or postural changes (20). In our study, it was observed that the character of the murmur changed with postural changes and Valsalva maneuver in children with innocent murmur.

In the study of Üner et al., the severity of the murmur in children with an innocent murmur was found to be 99.5% first and second degree (12). In our study, all children had a murmur of varying severity. 98.2% of these murmurs were first and second degree soft midsystolic short and non-invasive murmurs. 98.9% of the murmurs were murmurs that were not accompanied by any additional sounds.

Many studies have been conducted on the necessity of ECG and telecardiography in the evaluation of murmurs. In the study of Kozan et al., Cardiothoracic rates (CTO) were found within normal limits in children with innocent murmur in telecardiography and no difference was found with the control group (13). In the study of Mackie et al., it was shown that ECG in newborns does not contribute to the differential diagnosis of murmur (21). Since the American Heart Academy (AHA) 2008 did not recommend telecardiography in children who were thought to have innocent murmur with physical examination findings, none of the children participating in our study had telecardiography (22).

In the study of Smythe et al., for 161 patients whose physical examination and ECHO and ECG findings were examined, the sensitivity of physical examination was found to be 96%, specificity 95%, positive predictive value 88%, and negative predictive value 98% (23). In a series of 200 cases by Mellies et al., the sensitivity and positive predictive value of physical examination were 92% and 99%, while the specificity was found to be 50-60%. In the study of Mackie et al., the sensitivity of physical examination in newborns was found to be 80.5%, specificity 90.9%, positive predictive value 91.9%, and negative predictive value 78.4% (24). The American Heart Academy (AHA) does not recommend performing ECG as a routine examination in children who are considered to have an innocent murmur with physical examination findings in the

2008 guideline (22). ECGs were performed on 34 children who participated in our study for different reasons. No rhythm changes requiring treatment and follow-up were detected. There was LVMB and TVR together in the LV in 12 cases and only minimal TVR in 16 cases. All ECG results were evaluated as normal.

In the literature, when two groups before and after school are compared, the frequency of innocent murmur was found to be 1 to 2 times higher in the school age group compared to the preschool group (18). In the study of Kozan et al., 36.7% of the cases diagnosed with innocent murmur were from 0 to 6 age group and the rest were the school age group (13). When the age distribution of the children included in our study was examined, it was seen that 62.4% were in the preschool age group (<60 months) and 37.6% were in the school age group (>60 months). The frequency of innocent murmurs was found 1.6 times more common in preschool age than in school period.

In the literature, false negativity was found with a rate of 0.7-4% in children with suspected innocent murmur with auscultation (25). The most common pathologies that could not be detected by auscultation were reported as small ASD, VSD, MVP, and mild PS (26). In our study, PDA showing a fine flow pattern without hemodynamic significance in minimal TVR coexistence was observed in 13 children with innocent murmur and trivial AR was observed in 18 cases.

The causes of innocent murmurs are unclear. According to Van Oort et al, vibratory innocent murmurs are caused by turbulence caused by physiological narrowing of the LV outflow tract due to the high myocardial contractility in children (19). Since both myocardial contractility and systolic velocity are higher in children compared to adults, it supports this view. The murmur relationship with the bands in the LV has also been the subject of many studies. Brenner et al. reported the incidence of innocent murmur in healthy children as 29.3%. Its relation with innocent murmurs has been found with a rate of 63.6-77% in different studies (27). In the study of Özme et al., the relationship between the structure of the bands in the LV and the severity and shape of the murmur was examined, and it was found that longitudinal bands were associated with pulmonary ejection murmurs (28). ECHO findings were examined in our study. While minimal TVR was detected in 429 cases (85.8%) in color doppler echocardiographic examination, an LVMB was observed in 171 cases (30.6%). All of the LVMB's detected in our study were longitudinal bands. Also, there was no difference between genders. There are a few studies in the literature on valve regurgitation in normal subjects. In a study conducted by Kostucki et al. 92% minimal PVR, 40% minimal MVR, 44% minimal TVR, and 33% minimal AS were found in normal cases in adults (29). In the study conducted by Kozan et al. in children from Turkey, minimal regurgitation was found at the same rates in the tricuspid and pulmonary valve (13). In the study of Üner et al., TR was found in 25% of the patients with

an innocent murmur, and PY was found in 4% (12). In the study of Van Dijk et al. in 173 school-age children with murmurs, minimal TR was seen in 75% of children (30). In our study, the most common minimal valve regurgitation was seen in 429 cases (85.8%) in the Tricuspid valve, this was the mitral valve in 85 cases (15.7%), the aortic valve in 18 cases (3.4%), and the pulmonary valve was observed to follow with 9 cases (1.8%).

In this study, minor pathological findings were investigated by evaluating the children's ECHO findings. Considering the known causes of innocent murmur, minimal deficiency in AV valves was detected in 86% of all children diagnosed with innocent murmur. There was no rheumatic heart disease or systemic disease that could cause this together with additional pathological findings accompanying these deficiencies. Therefore, if the cases that may cause AV valve regurgitation are ruled out, the failure does not progress, and there is no impairment in cardiac functions, then minimal valve regurgitation should be considered as innocent murmur and unnecessary examinations and monitoring should be avoided. However, this study was planned cross-sectionally and conducted with a selected group. Further double-blinded controlled studies are needed to investigate the relationship between minimal valve regurgitation and innocent murmur.

Murmurs were heard during routine examination of healthy children cause serious anxiety in families. Even if the pediatrician thinks that the murmur is innocent, it is often inadequate to relieve families' anxiety. However, it has been shown that anxiety decreases in families of children diagnosed with innocent murmur by a pediatric cardiologist (31, 32). Although the diagnosis of CHD is desired early, great care should be taken in making the diagnosis. Unnecessary long-term cardiac monitoring and unnecessary drug use should be avoided in a large group with innocent murmur. It should be explained to the family that innocent murmurs can be seen quite frequently in the childhood age group, that there will be no problems in the future due to murmur, no restriction of physical activities, and long-term cardiac monitoring is not required. Therefore, we think that it is important to evaluate all children with murmurs at least once by a pediatric cardiologist and demonstrate the accuracy of the diagnosis with ECHO in terms of relieving the anxiety of both the family and the child.

Conflict of interest

The authors declared no conflict of interest.

Funding

No funding was used for the study.

Acknowledgments

None to declare.

Authors' contributions

Concept: N.T.P., S.T., Design: N.T.P., Data Collection or Processing: N.T.P., T.T., Analysis or Interpretation: N.T.P., Literature Search: N.T.P., Writing: N.T.P.

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