Innocent Heart Murmurs from the Perspective of the Pediatrician

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ABSTRACT

Innocent heart murmurs are quite common in children and adolescents. These murmurs are physiologic in nature and are not associated with any structural heart disease. Not only does the idea of having a child with a murmur bring unnecessary unrest to families, but the child also often goes through numerous tests that could be avoided. It is critical to obtain a detailed history and perform a thorough physical examination to diagnose these innocent murmurs. This article reviews the different types of innocent murmurs, their characteristics, how they can be differentiated on the physical examination, and most importantly, how they can be differentiated from pathologic murmurs, which require referral to a pediatric cardiologist and additional testing. [Pediatr Ann. 2016;45(8):e306-e309.]

Heart murmurs are common in children. About 50% of all children have a heart murmur sometime during childhood, and most of these are innocent murmurs. Also known as functional or physiologic murmurs, innocent murmurs refer to the sound produced by turbulence of blood as it flows through the normal heart or major blood vessels. Innocent murmurs vary based on physiologic changes that occur within the child’s body, such as cases where cardiac output is increased or with anemia. At the same time, many congenital and acquired heart diseases could also present with a heart murmur. The incidence of congenital heart disease is about 8 in 1,000 live births. With a thorough history and physical examination, the majority of innocent heart murmurs can be correctly identified by the pediatrician. The key features that would aid in differentiating innocent murmurs from pathologic ones are discussed further in the article.

HISTORY AND PHYSICAL EXAMINATION

A detailed history tailored to the age of the child should be obtained. In infants, the amount as well as frequency of feeds and the time taken to finish the feed should all be noted. Infants with pulmonary overcirculation or decreased cardiac function present with increased sweating with feeds, increased time to finish the feed, or they might take multiple breaks while feeding. Difficulty in breathing, fast breathing, or bluish discoloration of oral mucosa can occur with structural heart disease. In older children, presenting symptoms could be shortness of breath, racing heart, chest pain, or fainting episodes. Information about patient’s exercise tolerance can be acquired by asking whether the child is able to function at the same level as classmates at school. Also, questions should be asked regarding symptoms with activity, such as syncope, chest pain, palpitations, or feelings of dizziness. If any of these alarming symptoms are present, an evaluation by a pediatric cardiologist is needed.

In infants, a detailed prenatal and birth history should be obtained. Maternal illnesses or exposure to drugs or teratogens can affect the fetal cardiac structure and function. Gestational diabetes is associated with increased incidence of transposition of great arteries as well as reversible ventricular hypertrophy in infants. Maternal autoimmune diseases can lead to fetal heart block.

Many heart conditions show increased familial incidence. Inquire about history of congenital heart defect, genetic conditions like Marfan’s syndrome, hypertrophic or dilated cardiomyopathy, long QT syndrome, idiopathic sudden death or sudden infant death syndrome in first- and second-degree relatives. The presence of such conditions in the family should prompt further cardiac evaluation.
A detailed physical examination should be performed, with careful attention given to the cardiorespiratory system.

**General Examination**

Growth of the child should be assessed. Conditions with pulmonary overcirculation or decreased cardiac output are associated with poor growth. In these instances, the patient’s weight tends to be more affected than his or her height. In the general examination one should look for the presence of dysmorphic features that pertain to genetic syndromes associated with structural heart defects. Children with physical features of Down syndrome, Turner syndrome, Noonan syndrome, Marfan syndrome, or other conditions need a more detailed cardiac evaluation.

The clinician should look for pallor and cyanosis. Central cyanosis is clinically apparent as bluish discoloration of oral mucosa and nail beds. It can be easily recognized on examination when oxygen saturation is below 85%, but mild cyanosis can also be noted with pulse oximetry. Vital signs as well as pulse oximetry should be obtained. Tachypnea and increased respiratory effort could indicate structural heart disease. Heart rate and rhythm should be assessed. It is important to feel all peripheral pulses and to look for any brachiofemoral delay. Variation of heart rate with respiration (ie, sinus arrhythmia) is a normal phenomenon, and heart rate increases with inspiration. This is frequently readily appreciated when checking the pulse rate or when auscultating the heart sounds in young children.

Blood pressure should be obtained in the right upper extremity using the appropriate cuff. If the femoral pulse volume appears weaker or when there is any brachiofemoral delay, obtain blood pressure in one of the lower extremities to look for evidence of coarctation of the aorta. Extremities should be evaluated for edema and capillary refill.

**Pertinent Other Systems**

Lung fields should be auscultated to look for ronchi or crackles suggesting pulmonary edema. Look for evidence of hepatomegaly as well.

**Cardiac Examination**

Examine the precordium for any visible pulsations or chest wall deformities. On palpation of the precordium, presence of an abnormal apical impulse, thrill, or right parasternal heave is indicative of structural heart disease.

**Auscultation.** Systematic auscultation of all four cardiac areas should be performed. Each temporal event in the cardiac cycle has to be given attention separately. In each of the areas of auscultation, evaluate the first heart sound (S1), second heart sound (S2), events occurring between S1 and S2 (systolic), and those occurring between S2 and the next S1 (diastolic).

**First heart sound.** The first heart sound is a low-frequency sound best heard at the apex of the heart and the left lower sternal border. The timing of S1 corresponds with the closure of mitral and tricuspid valves. With closure of valves, there is a sudden deceleration of blood flow that causes vibrations in the valve apparatus as well as cardiac chambers, resulting in the S1. Even though the S1 has two components (tricuspid and mitral), in most instances it is appreciated as a single sound.

**Second heart sound.** This is higher pitched and shorter than S1 and is best heard at the left upper sternal border. S2 corresponds temporally to the closure of the semilunar valves. S2 has an aortic component (A2) that occurs first and a pulmonary component (P2) that occurs later. S2 is physiologically split due to the latency of the pulmonic valve closure. Normally, the splitting of S2 shows variation with the phase of respiration. With a deep inspiration, there is increased systemic venous return that increases the ejection time of the right ventricle. The pulmonary valve closure is thus delayed, resulting in widening of the interval between A2 and P2 in inspiration. This is an important finding in identifying structural heart disease.

**Third heart sound.** The third heart sound (S3) occurs due to the rapid filling of ventricles during early diastole. This is normal in children at times of increased cardiac output. Exercise, fever, or any other condition correlated with increased cardiac output in children can be associated with S3 on physical examination. It can also be heard pathologically in congestive heart failure.

**Fourth heart sound.** The fourth heart sound (S4) is a late diastolic sound that is heard just before S1. S4 is always pathologic. It is due to late rapid ventricular filling that occurs as the atria contracts against a stiff ventricle. S4 is most commonly heard in congestive heart failure and other conditions associated with decreased ventricular compliance.

As the heart rate increases, it is quite difficult to differentiate between S3 and S4. During tachycardia S1, S2, and S3/S4 together produce a rhythm that sounds like the galloping of a horse.

**Click.** Presence of a click is indicative of structural heart disease. Clicks are higher pitched compared with other heart sounds. Systolic ejection clicks are heard with stenosis of aortic or pulmonary valves. Mid-diastolic clicks over the apex are indicative of mitral valve prolapse.

**INNOCENT HEART MURMURS**

Innocent heart murmurs are caused by blood flow through the normal heart and vessels that branch out of the heart.
They are affected by exercise, anxiety, fever, and anemia, because these states alter the cardiac output and affect the blood returning to the heart. Many innocent murmurs also vary with a change in posture. Each murmur is categorized based on its timing during the cardiac cycle, location, quality or pitch, and intensity or loudness.¹

Certain characteristics that should alarm the physician that a murmur may be pathologic are holosystolic murmur (grade 3 or higher), maximal intensity at the upper left sternal border, a systolic click, diastolic murmur, or increased murmur intensity with standing.⁴ Although these characteristics make the murmur more likely to be pathologic, characteristics such as systolic murmur, soft sound, short duration, musical or low pitch, and varying intensity with phases of respiration and posture; and murmurs that become louder with exercise, anxiety, or fear are thought to be more innocent in nature.³

There are several murmurs in infants, children, and adolescents that are benign in nature. The most common ones—Still’s murmur, venous hum, pulmonic flow murmur of infancy, and supraclavicular bruit—are discussed next. The ability to differentiate these innocent murmurs from the pathologic murmurs allows the pediatrician to decide when it is appropriate to refer these children to a pediatric cardiologist.

**Still’s Murmur**

First described by George F. Still, Still’s murmur is the most common innocent heart murmur of childhood. It can occur any time from infancy to adolescence, but is most common between ages 3 and 6 years.³⁵ It is usually a grade 1 to 3, low-frequency murmur heard best over the left lower sternal border as well as the cardiac apex. It has a classic vibratory or pleasant musical quality that has been likened to the vibrations of a taut string. The murmur is loudest when the child is in the supine position. Still’s murmur varies with respiration. It is louder in expiration and becomes softer with deep inspiration. The exact etiology of Still’s murmur has not been clearly defined yet. It has been proposed that it originates from increased velocity of flow as blood is pumped into the aorta from the left ventricle. Other theories implicate vibrations of the mitral valve chordae or left ventricular false tendons as the cause for Still’s murmur. Heard in normal and healthy children, this easily recognizable murmur warrants no additional investigation.

**Pulmonary Flow Murmur of Childhood**

Frequently heard in young children and adolescents, this murmur arises from the flow of blood across a normal pulmonary valve. The anterior position of the pulmonary valve makes it easy to detect this murmur in young children and adolescents who have a thin chest wall. It is a grade 1 to 3 ejection systolic murmur best appreciated over the left upper sternal border. The murmur is louder in intensity in the supine position or in conditions with increased cardiac output such as exercise, excitement, anemia, or fever. Absence of an ejection systolic click or thrill helps to differentiate this from pulmonary valve stenosis. It is important to carefully assess the S2 in this context. S2 is normal in instances of pulmonary flow murmur of childhood. A widely split S2 with no respiratory variation signifies structural defects with increased pulmonary flow, such as an atrial septal defect.

**Pulmonary Flow Murmur of Infancy**

Also known as physiologic branch pulmonary stenosis of infancy, pulmonary flow murmur of infancy is characterized by a grade 1 or 2, low-pitched, early- to mid-systolic ejection murmur that is best heard over the second left intercostal space, and that radiates to the axilla as well as the back. A normal second heart sound and absence of ejection click differentiates this from valvar pulmonary stenosis. In a fetus, only about 10% of the cardiac output flows through the branch pulmonary arteries whereas the rest bypasses the lungs and goes down the ductus arteriosus into the descending aorta. Postnatally with ductal closure, the entire right ventricular output has to flow through the relatively small branch pulmonary arteries, which create turbulence of flow. The branch pulmonary arteries of a newborn arise at an acute angle from the postero-inferior aspect of the main pulmonary artery. This orientation of vessels has also been implicated as the cause of pulmonary flow murmur of newborn. This murmur usually disappears by age 3 to 6 months.³ Persistence beyond age 6 months should prompt further evaluation.

**Supraclavicular/Carotid Bruit**

Supraclavicular bruit is a high-pitched systolic murmur best heard in the supraclavicular area, predominantly on the right side. It originates from the flow of blood into the aortic branches. Hyperextension of the shoulders along with apposition of elbows over the back reduces the intensity of this murmur. A pathologic murmur arising from the left ventricular outflow tract would be loudest over the second right intercostal space or the left sternal border. An ejection systolic click could also be present in such instances.

**Venous Hum**

Usually all innocent murmurs are systolic in nature. Venous hum is the exception. Venous hum is a continuous
murmur, usually louder in diastole, that is heard best over the anterior neck lateral to the sternocleidomastoid muscle, especially on the right side. Venous hum is produced by turbulent flow of systemic venous blood in the jugular veins and superior vena cava. Heard commonly between ages 3 and 8 years, the venous hum is a low-pitched murmur that varies from grades 1 to 6 in intensity and sounds like a waterfall with a whining or roaring quality. Its pitch and intensity vary with the cardiac cycle as well as with phase of respiration. Venous hum depends on the effect of gravity and so is heard in the upright position. Stretching of the neck, which occurs when the child looks up to the contralateral side, helps in bringing out this murmur. The hum disappears in the supine position. Maneuvers like digital compression over the jugular vein, Valsalva, or turning the head back to the neutral position abolishes this murmur or reduces its intensity.

In most instances, innocent heart murmurs can easily be identified by taking a detailed history and performing a thorough physical examination. Castellotti et al.6 looked at the incidence of innocent murmurs and how primary care physicians correctly identified them. It was concluded that as long as primary care physicians believe that the criteria for innocent murmurs are met, such as being early in systole, low intensity, and no other associated signs and symptoms of heart disease, then the accurate diagnosis can be made without the help of the pediatric cardiologist.6 However, in cases where it is not clear if the murmur is innocent, the primary care physician should refer the patient to a pediatric cardiologist for further evaluation. Ordering additional testing at this point is not a good strategy and can be left to the discretion of the pediatric cardiologist. Chest X-rays and electrocardiogram lack sensitivity as well as specificity in differentiating innocent heart murmurs from those caused by structural heart disease. Echocardiogram will detect any underlying structural heart disease; however, it adds to the financial burden and in many cases may be quite unnecessary. In their study assessing the cost for evaluation of heart murmurs, Danford et al.7 have shown that it is more cost effective to refer patients to a pediatric cardiologist rather than ordering laboratory tests such as X-rays or echocardiograms prior to referral. Smythe et al.8 concluded in their study that pediatric cardiologists have been shown to be more effective at differentiating innocent murmurs from pathologic murmurs without the use of laboratory tests.

CONCLUSION

Innocent heart murmurs, which are a common pediatric finding, are often a cause of parental anxiety. Parents are frightened when they first hear the word “murmur” from their primary care physicians. Not only do parents start unnecessarily restricting their children from physical activity, but they also think of the murmur as a heart disease that will affect their child’s entire life. With a detailed history and a careful physical examination, primary care physicians can differentiate innocent from pathologic murmurs in most instances. Imaging studies such as chest X-ray or echocardiogram are not usually needed for the diagnosis of innocent murmur. Upon diagnosis of the common innocent murmurs discussed in this article, the physician should educate the parents about the benign condition of these murmurs. Parents should be reassured that their children with benign murmurs do not have any underlying structural heart disease. Neither restriction of physical activities nor infective endocarditis prophylaxis is warranted in these children. No further cardiac follow-up is needed for innocent heart murmurs. When in doubt about the nature of the heart murmur, the primary care physician should refer the patient to a pediatric cardiologist rather than ordering additional testing.

REFERENCES