DOPPLER PARAMETERS OF INNOCENT MURMURS*

Yelda Başaran, MD*; Mehmet Özkan, MD*; Müjdat Başaran, MD**

From: *Koşuyolu Heart and Research Hospital, **Marmara University, School of Medicine

Address for reprints:
Yelda Başaran, M.D.
Koşuyolu Heart and Research Hospital,
Istanbul, Türkiye

Since innocent murmurs are heard in 30-50% of normal children from infancy through adolescence, it is important to find some objective Doppler criteria to define the mechanism(s) of innocent murmurs.

In comparison of pulmonary and aortic time and velocity parameters in murmur and control groups; pulmonary preejection period (PEP) and peak velocity, aortic peak velocity is significantly higher in the murmur group ($p<0.05$). Waveform contour ratio is also higher in the murmur group.

Our results reflects that higher aortic and pulmonary peak velocities are responsible for innocent murmurs along with decreased compliance and/or increased arterial impedence of the right heart.

Key words: Innocent murmurs, Doppler, Continuous wave

Murmurs that are not associated with any anatomic or physiologic abnormality are called innocent murmurs. They occur in early systole, generally of short duration and low intensity, crescendo-decrescendo in quality and poorly transmitted elsewhere[1-3].

The possible hemodynamic mechanisms of the innocent murmurs was investigated non-invasively by Doppler echocardiography. It has been proposed that turbulence in the great arteries creates innocent murmurs. Slight angulation, and the narrower passage has been accused as a reason of turbulence[1,3]. Intracardiac phonocardiograhic studies claimed that innocent murmurs mostly originated from the right heart[2].

More recently, some investigators suggested that aortic valve was the source of these murmurs. According to this view, damping effect of more compliant pulmonary artery does not likely seem to be responsible for murmurs[4].

It has been claimed that murmur was related to the finding of small ascending aortic diameter associated with concomitant high aortic blood flow velocity[5]. In some studies, higher aortic peak velocity despite insignificant difference in cardiac output was found[6]. Decreased blood viscosity also contributes to the production of innocent murmurs[7].

*Presented at the 32th Annual Meeting of International College of Angiology, July 1990, Toronto, Canada.

Materials and Methods

Thirty children (8 girls, 22 boys) ranged between 5-12 years old with innocent murmurs was included in the study. In murmur group, any condition which may cause functional murmurs in children (e.g. anemia, acute infection, fever) was excluded. History, physical examination, ECG and the chest X-ray revealed no cardiac, and extra-cardiac systemic illness in any subject.

Doppler examinations were performed while patients in the left lateral decubitus position with General Electric Phass 2000 2-Dimensional sector/continuous wave Doppler flowmeter with 5 MHz transducer. During Doppler examination simultaneous ECG were also recorded. Pulmonary and aortic flows were recorded with continuous wave (CW) technique. For the right ventricular outflow signal, the transducer was positioned in the middle left parasternal border and parasternal short axis 2-Dimensional view was used. Sample volume marker was positioned just proximal to the pulmonary valve. Left ventricular outflow tracings were obtained using apical two chamber view, and sample volume was positioned to the left ventricular outflow tract, proximal to the aortic valve. At least 5 cardiac cycles were recorded with 100 mm/sec paper speed.

For each flow pattern, preejection period (PEP), ejection time (ET) and mean acceleration to peak velocity (ACCm) (peak velocity/ acceleration time) was measured, and average values was obtained for each parameters.

All measurements were made from the outer borders of the darkest portion of the spectral patterns. Doppler flow signals were obtained using lowest wall filter settings that would allow an accurate identification of onset and termination of the flow pattern.

The expression F(PEP x ACCm)/ET and the ratio of F for the right outflow to F for the left outflow (waveform contour ratio) was calculated.

Statistical Analysis: All results expressed as mean ± standart deviation. Paired and unpaired student's t-test was applied for significance tests.

Results

The mean values of pulmonary and aortic time and velocity parameters in murmur and control groups are shown in Tables I and II.

Pulmonary parameters: PEP and peak velocity are significantly higher in murmur group.

For aortic parameters: Peak velocity was significantly higher in murmur group ($p<0.05$).

Pulmonary and aortic parameters were also compared in each group separately.

Murmur Group: (Table III)

Pulmonary AT is significantly longer than aortic parameters ($p<0.001$).

Control Group: (Table IV)

Pulmonary AT was significantly longer, ($p<0.01$) and pulmonary PEP is significantly shorter ($p<0.001$) than their aortic counterparts.

Table I: Time and velocity indexes of pulmonary artery (see text for abbreviations)

	CW (mean ± SD)		
	murmur(n:30)	control (n:30)	P
PEP	9.77±2.15	7.68±1.99	<0.01
ET	25.66±3.36	25.93±3.71	NS
AT	11.33±2.19	10.50±2.96	NS
PV	0.89±0.21	0.70±0.16	<0.05

NS: Not significant

Table II: Time and velocity indexes of aorta (see text for abbreviations)

	CW (mean ± SD)		
	murmur (n:30)	control (n:30)	P
PEP	9.18±2.85	9.66±2.05	NS
ET	24.62±4.03	24.00±2.66	NS
AT	8.75±1.80	8.33±1.43	NS
PV	0.92±0.15	0.82±0.16	<0.05

NS: Not significant

Table III: Comparison of pulmonary and aortic parameters in murmur group

	CW (mean ±SD)		
	Pulmonary	Aorta	P
PEP	9.77±2.15	9.18±2.85	NS
ET	25.66±3.36	24.62±4.03	NS
AT	11.33±2.19	8.75±1.80	<0.001
PV	0.89±0.21	0.92±0.15	NS

NS: Not Significant

Waveform contour ratio is 0.59 in murmur group while it is 0.41 in control group. The difference is statistically significant ($p<0.05$) (Table V).

Discussion

Innocent murmurs are short systolic ejection murmurs located at the left sternal border without any underlying cardiac or extracardiac pathology[2,3,9].

It is highly seen frequently in the pediatric age group(up to 50% of children), with no clinical significance but may cause diagnostic problems for the general practitioners and unnecessary anxiety for the families. Left ventricular fibrous bands have been suggested for the cause of innocent murmurs but causal relationship is poorly documented[10,15].

The hemodynamic mechanism of these murmurs is poorly understood because invasive studies are naturally lacking. Noninvasive hemodynamic studies like echocardiography may shed light into the mechanism of innocent murmurs[1].

Table V: Waveform Contour Ratio for Murmur and Control Groups

	Murmur Group	Control Group
Pulmonary F	3.19±1.48	2.58±1.83
Aortic F	4.03±1.54	4.37±1.61
Pulm/Ao F	0.59±0.25	0.41±0.18

Table IV: Comparison of pulmonary and aortic parameters in control group

	Pulmonary	Aorta	P
PEP	7.68±1.99	9.66±2.05	<0.001
ET	25.93±3.71	24.00±2.66	NS
AT	10.50±2.96	8.33±1.43	<0.01
PV	0.70±0.16	0.82±0.16	NS

NS: Not significant

Our results give an impression that high pulmonary and aortic peak velocities are related to innocent murmurs.

Since ejection time is similar in both groups, increased stroke volume does not seem to be responsible for the generation of murmurs. Any reason which cause increased preejection period may also be implicated for the mechanism of right sided innocent murmurs.

Duration of PEP is inversely proportional to myocardial contractility, and directly related to arteriel pressure and impedence. Pulmonary PEP/ET ratio is increased in the murmur group. Since this ratio is inversely related to ejection fraction, it may indicate a minor decrease in right ventricular compliance. Slight angulation or anatomic variation causing narrower passage of right ventricular outflow may cause prolongation of preejection period in murmur group.

Comparison of pulmonary and aortic parameters in each group showed longer aortic acceleration time than the pulmonary. This is an expected waveform characteristic obtained from high pressure left ventricular outflow.

Waveform contour ratio is a relative value that takes into account the effects that pulmonary and systemic circulations have on each other. In our study this ratio is significantly higher in murmur group. Difference in pressure related right and left sided flow velocity characteristics may imply slight pressure and impedence increase of right side in murmur group than control regardless of absolute values.

In conclusion, higher peak velocities of pulmonary and aorta in murmur group play an important role in the mechanism of innocent murmurs. Additionly, inertial and resistive properties of right ventricular outflow tract along with diminished compliance may contribute to the formation of right sided innocent murmurs.

Further studies screening large groups of children are needed in order to determine hemodynamic and/or anatomical variations such as fibrous bands in innocent murmurs.

References

1- Newburger JW, Rosenthal A, Williams RG, Fellow K, Miettinen OS: Noninvasive tests in the evaulation of heart murmurs in children. N Eng J Med 1983;308:61-64.

2- Rosenthal A: How to distinguish between innocent and pathologic murmurs in childhood. Ped Clin North Am 1984;31:1229-1233.

3- Paraskos JU: The innocent murmur. Hosp Prac 1988;30:20-25.

4- Stein PD, Sabbah HN: Aortic origin of innocent murmurs. Am J Cardiol 1977;39:665-667.

5- Schwartz ML, Goldberg SJ, Wilson N, Allen HD, Marx GR: Relation of Still's murmur, small aortic diameter and high aortic velocity. Am J Cardiol 1986;57:1344-1349.

6- Sholler G, Selermajer J, Wright C: Doppler echocardiographic assesment of cardiac output in normal children with or without innocent precordial murmurs. Am J Cardiol 1987;59:487-488.

7- Sabbah HN, Lee TG, Stein PD: Role of blood viscosity in the production of innocent ejection murmurs. Am J Cardiol 1979;43:753-757.

8- Morera M, Hoadley S, Roland M: Estimation of the ratio of pulmonary to systemic pressures by pulsed-wave Doppler echocardiography for assesment of pulmonary arterial pressures. Am J Cardiol 1989;63:862-866.

9- Kulengara RJ, Strong WB, Miller MD: Differential diagnosis of heart murmurs in children. Postgrad Med 1982;72:219-224.

10- Darazs B, Hesdorffer CS, Butterworth AM, Ziady F: The possible etiology of the vibratory systolic murmur. Clin Cardiol 1987;10:341-344.

11- Mino CY, Zuberbuhler VS, Zuberbuhler JR: Genesis of vibratory functional murmurs. Am J Cardiol 1987;60:1198-1201.

12- Lindwall K, Olsson G, Sjögren A: False tendons in the left ventricle 2-Dimensional and M-mode echocardiographic findings. Acta Med Scand 1982;212:93-95.

13- Caste A, Wolf W: Left ventricular bands. (False tendons): Echocardiographic and angiocardiographic delineation in children. Am Heart J 1986; 111:321-325.

14- Bremer J, Ringel R, Berman M: Echocardiographic evidence of left ventricular bands in infants and children. J Am Coll Cardiol 1984;3:1515-1520.

15- Perry L, Ruchman R, Shapiro S, Kuehl K: Left ventricular false tendons in children: Prevalance as detected by 2-Dimensional echocardiography and clinical significance. Am J Cardiol 1983; 52:1264-1266.