DOPPLER
PARAMETERS OF
INNOCENT MURMURS*

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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; pulmonaty 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 impedance 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
elsewhere1-3.

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 turbulence1,3. Intracardiac phonocardiographic studies claimed
that innocent murmurs mostly originated from the right heart2.

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 murmurs4.

It has been claimed that murmur was related to the finding of small
ascending aortic diameter associated with concomitant high aortic blood
flow velocity5. In some studies, higher aortic peak velocity despite
insignificant difference in cardiac output was found6. Decreased blood
viscosity also contributes to the production of innocent murmurs7.

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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, prejection 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 ± standard 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)

<table>
<thead>
<tr>
<th></th>
<th>CW (mean ± SD)</th>
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<tbody>
<tr>
<td></td>
<td>murmurs (n:30)</td>
<td>control (n:30)</td>
</tr>
<tr>
<td>PEP</td>
<td>9.77±2.15</td>
<td>7.68±1.99</td>
</tr>
<tr>
<td>ET</td>
<td>25.66±3.36</td>
<td>25.93±3.71</td>
</tr>
<tr>
<td>AT</td>
<td>11.33±2.19</td>
<td>10.50±2.96</td>
</tr>
<tr>
<td>PV</td>
<td>0.89±0.21</td>
<td>0.70±0.16</td>
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Table II: Time and velocity indexes of aorta (see text for abbreviations)

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<th></th>
<th>CW (mean ± SD)</th>
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<tbody>
<tr>
<td></td>
<td>murmurs (n:30)</td>
<td>control (n:30)</td>
</tr>
<tr>
<td>PEP</td>
<td>9.18±2.85</td>
<td>9.66±2.05</td>
</tr>
<tr>
<td>ET</td>
<td>24.62±4.03</td>
<td>24.00±2.66</td>
</tr>
<tr>
<td>AT</td>
<td>8.75±1.80</td>
<td>8.33±1.43</td>
</tr>
<tr>
<td>PV</td>
<td>0.92±0.15</td>
<td>0.82±0.16</td>
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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\(^1\).

The 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 arteriolar pressure and impedance. 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 impedance 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.

<table>
<thead>
<tr>
<th>Table V: Waveform Contour Ratio for Murmur and Control Groups</th>
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<tbody>
<tr>
<td><strong>Murmur</strong></td>
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<tr>
<td><strong>Group</strong></td>
</tr>
<tr>
<td>Pulmonary F</td>
</tr>
<tr>
<td>Aortic F</td>
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<td>Pulm/Ao F</td>
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murmurs. Additionally, 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


