Simplified Vectorcardiographic Method for Assessment of Pulmonary Arterial Pressure in Children with Chronic Rheumatic Mitral Valve Disease*

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SUMMARY

We previously reported that pulmonary artery pressures can be assessed in children with chronic rheumatic mitral valve disease by measuring right maximum spatial vector from Frank vectorcardiogram. To simplify the calculation, pulmonary artery systolic pressure was correlated with maximum negative deflection on Frank scalar X-lead (SX), maximum negative deflection on scalar Z lead (SZ), sum total of SX and SZ (SX+SZ) and combined SX and SZ. The patient material consisted of 30 children with chronic rheumatic mitral valve disease, aged 8–14½ years. Eleven were male and 19 were female. Sixteen had mitral stenosis, 8 had mitral regurgitation, and 6 had combined mitral regurgitation and stenosis, documented by cardiac catheterization and angiographic study. The results showed a significant correlation between pulmonary artery systolic pressure and SX (r=0.782). As calculation of SX is considerably easier and less time consuming than that of right maximum spatial vector, this simplified method is preferable to right maximum spatial vector for prediction of the pulmonary artery systolic pressure of children with pulmonary hypertension due to chronic rheumatic mitral valve disease.

Additional Indexing Words:
Right maximum spatial vector Frank scalar X-lead Mitral stenosis Mitral regurgitation Pulmonary hypertension

Electrovectorcardiographic parameters have been used for prediction of hemodynamic variables in various cardiac disorders. We previously reported that right maximum spatial vector (Rmsv) calculated from Frank vectorcardiogram is a useful index for assessment of pulmonary arterial pressures in children with chronic rheumatic mitral valve disease. As cal-

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*Supported by the general research fund of the Queen Pahlavi Foundation Cardiovascular Medical Center.

Received for publication January 7, 1976.
calculation of Rmsv necessitates several measurements and the use of the Pythagorean theorem, we explored the possibility of using simple scalar measurements for prediction of pulmonary artery systolic pressure (PAS) in these children with pulmonary hypertension due to chronic rheumatic mitral valve disease. The purpose of this report is to compare the correlation between these simplified measurements and Rmsv with PAS.

**Materials and Methods**

Data on 30 children with chronic rheumatic mitral valve disease aged 8–14\(\frac{1}{2}\) years were selected from consecutive admissions for cardiac catheterization to the Pediatric Cardiology Department of the Queen Pahlavi Foundation Cardiovascular Medical Center. Details of the methods and comprehensive data were described elsewhere.\(^2\) Briefly all patients were catheterized in resting state 1 hour after 1 mg/Kg meperidine, IM (maximum 50 mg). All patients with significant tricuspid and/or aortic regurgitation as documented by hemodynamic and angiographic studies were excluded. Pulmonary artery and aortic pressures used for calculations were recorded simultaneously prior to the angiographic study. Frank vectorcardiogram was obtained in supine position. Frank scalar leads X, Y, and Z were recorded at 50 and 250 mm/sec. Using routine statistical calculations\(^10\) PAS was correlated with the following measurements:

1. Maximum negative deflection on scalar lead X (SX).
2. Maximum negative deflection on scalar lead Z (SZ).
3. Algebraic sum of SX and SZ voltages (SX+SZ).
4. SX and SZ multiple correlation.

**Results**

Eleven patients were male and 19 were female. Sixteen patients had mitral stenosis (MS), 8 had pure mitral regurgitation (MR), and 6 had combined mitral regurgitation and stenosis. Table I shows mean ±1SD values for aortic, pulmonary arterial, and mean pulmonary arterial wedge pressures.

**Table I. Mean±1SD Values for Aortic, Pulmonary Arterial, and Pulmonary Arterial Wedge Pressures in 30 Children with Chronic Rheumatic Mitral Valve Disease**

<table>
<thead>
<tr>
<th>Pressures (mmHg)</th>
<th>Systolic</th>
<th>Diastolic</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ao</td>
<td>106.5±14.5</td>
<td>68±5.5</td>
<td>82.5±11</td>
</tr>
<tr>
<td>PA</td>
<td>76±28</td>
<td>36±15</td>
<td>51±20</td>
</tr>
<tr>
<td>PAW</td>
<td>—</td>
<td>—</td>
<td>23.5±5</td>
</tr>
</tbody>
</table>

Abbreviations: Ao = Aortic pressure; PA = pulmonary arterial pressure; PAW = pulmonary arterial wedge pressure.
Fig. 1. Scattergram showing the regression line correlating pulmonary artery systolic pressure (PAS) and maximum negative deflection on Frank scalar lead X (SX), for 30 children with chronic rheumatic mitral valve disease.

The correlation coefficients were as follows:

1. PAS and SX \( r = 0.782 \) \( p < 0.01 \)
2. PAS and SZ \( r = 0.524 \) \( p < 0.1 \)
3. PAS and (SX+SZ) \( r = 0.769 \) \( p < 0.01 \)
4. PAS and SX and SZ \( r = 0.600 \) \( p < 0.1 \)
5. PAS and Rmsv \( r = 0.773 \) \( p < 0.01 \)

Regression equation for prediction of PAS from SX is given below:

\[ \text{PAS} = 42.09 \times \text{SX} + 49.78 \]

where PAS is expressed in mmHg and SX in millivolts. Scattergram (Fig. 1) shows the regression line and correlation between PAS and SX.

**DISCUSSION**

Hugenholtz et al first reported a significant correlation between maximum spatial vector and left ventricular pressure in patients with congenital aortic stenosis.\(^3\) Since then several reports have appeared regarding the usefulness of maximum spatial vectors for prediction of various hemodynamic parameters. Thus regression equations and correlations have been defined for prediction of intracardiac pressures in aortic stenosis,\(^3,4\) transposition of the great arteries,\(^5,6\) secundum atrial septal defect,\(^7,8\) pulmonic stenosis\(^1\) and various other forms of congenital heart disorders from the maximum spatial vectors.\(^1\) The usefulness of Rmsv for prediction of pulmonary arterial
pressures in children with chronic rheumatic mitral valve disease was recently reported from this laboratory.\(^2\) Although maximum spatial vector is a useful index, however its calculation is time-consuming and necessitates multiple measurements by the Pythagorean theorem. Thus we explored the possibility of using other simple vectorcardiographic measurements for prediction of PAS in children with chronic rheumatic mitral valve disease. As described above SX bears a significant correlation with PAS as good as Rm sv (\(r=0.782\) vs \(r=0.773\)).\(^2\) Thus it is proposed to use this simplified method for noninvasive assessment of the PAS of children with chronic rheumatic mitral valve disease. It should be emphasized that the above correlations and regression equation are not applicable to patients with pulmonary hypertension due to other disorders.

**REFERENCES**

3. Hugenholtz PA, Gamboa R: Effect of chronically increased ventricular pressure on electrical forces of the heart. A correlation between hemodynamic and vectorcardiographic data, (Frank system) in 90 patients with aortic or pulmonic stenosis. Circulation 30: 511, 1964