Effect of Sampling Site on Doppler-Derived Right Ventricular Systolic Time Intervals

Elizabeth M. Shaffer, MD, A. Rebecca Snider, MD, Gerald A. Serwer, MD, Jane Peters, and Patricia A. Reynolds

E

From the Department of Pediatrics, C.S. Mott Children's Hospital, University of Michigan Medical Center, Ann Arbor, Michigan. Manuscript received May 1, 1989; revised manuscript received and accepted December 6, 1989.

Effect of Sampling Site on Doppler-Derived Right Ventricular Systolic Time Intervals

Elizabeth M. Shaffer, MD, A. Rebecca Snider, MD, Gerald A. Serwer, MD, Jane Peters, and Patricia A. Reynolds

E

From the Department of Pediatrics, C.S. Mott Children's Hospital, University of Michigan Medical Center, Ann Arbor, Michigan. Manuscript received May 1, 1989; revised manuscript received and accepted December 6, 1989.

Effect of Sampling Site on Doppler-Derived Right Ventricular Systolic Time Intervals

Elizabeth M. Shaffer, MD, A. Rebecca Snider, MD, Gerald A. Serwer, MD, Jane Peters, and Patricia A. Reynolds

E

From the Department of Pediatrics, C.S. Mott Children's Hospital, University of Michigan Medical Center, Ann Arbor, Michigan. Manuscript received May 1, 1989; revised manuscript received and accepted December 6, 1989.

Effect of Sampling Site on Doppler-Derived Right Ventricular Systolic Time Intervals

Elizabeth M. Shaffer, MD, A. Rebecca Snider, MD, Gerald A. Serwer, MD, Jane Peters, and Patricia A. Reynolds

E

From the Department of Pediatrics, C.S. Mott Children's Hospital, University of Michigan Medical Center, Ann Arbor, Michigan. Manuscript received May 1, 1989; revised manuscript received and accepted December 6, 1989.

Effect of Sampling Site on Doppler-Derived Right Ventricular Systolic Time Intervals

Elizabeth M. Shaffer, MD, A. Rebecca Snider, MD, Gerald A. Serwer, MD, Jane Peters, and Patricia A. Reynolds

E

From the Department of Pediatrics, C.S. Mott Children's Hospital, University of Michigan Medical Center, Ann Arbor, Michigan. Manuscript received May 1, 1989; revised manuscript received and accepted December 6, 1989.

Effect of Sampling Site on Doppler-Derived Right Ventricular Systolic Time Intervals

Elizabeth M. Shaffer, MD, A. Rebecca Snider, MD, Gerald A. Serwer, MD, Jane Peters, and Patricia A. Reynolds

E

From the Department of Pediatrics, C.S. Mott Children's Hospital, University of Michigan Medical Center, Ann Arbor, Michigan. Manuscript received May 1, 1989; revised manuscript received and accepted December 6, 1989.

Effect of Sampling Site on Doppler-Derived Right Ventricular Systolic Time Intervals

Elizabeth M. Shaffer, MD, A. Rebecca Snider, MD, Gerald A. Serwer, MD, Jane Peters, and Patricia A. Reynolds

E

From the Department of Pediatrics, C.S. Mott Children's Hospital, University of Michigan Medical Center, Ann Arbor, Michigan. Manuscript received May 1, 1989; revised manuscript received and accepted December 6, 1989.

Effect of Sampling Site on Doppler-Derived Right Ventricular Systolic Time Intervals

Elizabeth M. Shaffer, MD, A. Rebecca Snider, MD, Gerald A. Serwer, MD, Jane Peters, and Patricia A. Reynolds

E

From the Department of Pediatrics, C.S. Mott Children's Hospital, University of Michigan Medical Center, Ann Arbor, Michigan. Manuscript received May 1, 1989; revised manuscript received and accepted December 6, 1989.
Laboratories UltraMark 8 imaging system and 5-, 3.5- and 2.25-MHz mechanical transducers. Doppler tracings were recorded with the sample volume positioned in the right ventricle just proximal to the pulmonary valve, in the pulmonary trunk just distal to the pulmonary valve and in the pulmonary trunk midway between the pulmonary valve and the pulmonary trunk bifurcation (Figure 1). The Doppler tracings were recorded at a paper speed of 100 mm/s and wall filter settings of 200 Hz. RV systolic time intervals were measured (in ms) from each sample volume position on all study participants using the Doppler spectral tracings and the simultaneous electrocardiogram. The pre-ejection period was measured from the Q wave of the electrocardiogram to the onset of flow on the Doppler tracing. The acceleration time was measured from the onset of flow to the peak velocity of flow. The ejection time was measured from the onset of flow to the end of flow (Figure 2). A minimum of 3 cardiac cycles was measured at each sample volume position. The following variables were derived from the measured time intervals: the pre-ejection period corrected for heart rate was calculated as the uncorrected pre-ejection period plus 0.39 times the heart rate, and the ejection time corrected for heart rate was calculated as the uncorrected ejection time plus 1.3 times the heart rate. In addition, the ratios of pre-ejection period/acceleration time, acceleration time/ejection time and pre-ejection period/ejection time were calculated. The variables measured at each site were compared using a period t test and Bonferroni's correction for multiple comparisons. A 2-tailed p value < 0.04 indicated a significant difference between sites.

Table I lists the results of comparisons of the RV systolic time intervals obtained from the different sample volume positions. No differences were found in heart rate, pre-ejection period, ejection time or these time intervals corrected for heart rate at the 3 sample sites. The acceleration time was significantly shorter distal to the pulmonary valve and midway to the pulmonary trunk when compared to that obtained proximal to the pulmonary valve. There was no difference in the acceleration time measured just distal to the pulmonary valve and the acceleration time measured midway to the pulmonary trunk. Because of the differences observed in the acceleration time between sites, the acceleration time/ejection time ratio was significantly lower at both sites distal to the pulmonary valve compared to the site proximal to the pulmonary valve. The acceleration time/ejection time ratio just distal to the pulmonary valve was not different from the acceleration time/ejection time ratio measured midway in the pulmonary trunk. The pre-ejection period/acceleration time ratio measured just distal to the pulmonary valve was significantly higher than the pre-ejection period/acceleration time ratio measured proximal to the pulmonary valve. The pre-ejection period/acceleration time ratio measured midway in the main pulmonary artery was also higher than that measured proximal to the pulmonary valve but this value did not reach statistical significance. The pre-ejection period/ejection time ratio was not different among the 3 sampling sites.

Several Doppler echocardiographic techniques have been used to estimate the pulmonary artery pressure non-

FIGURE 1. Parasternal short-axis views showing the 3 Doppler sample volume positions: proximal to the pulmonary valve (left), just distal to the pulmonary valve (middle) and midway between the pulmonary valve and pulmonary bifurcation (right). AO = aorta; LA = left atrium; PA = pulmonary artery; RA = right atrium; RV = right ventricle.

FIGURE 2. Pulmonary artery Doppler tracing showing the measured systolic time intervals. AT = acceleration time; ET = ejection time; PEP = pre-ejection period.
TABLE I Comparison of Doppler-Derived Right Ventricular Systolic Time Intervals and Ratios Measured at Three Sampling Sites in 23 Patients

<table>
<thead>
<tr>
<th>Proximal Valve</th>
<th>Distal Valve</th>
<th>Midway MPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR (beats/min)</td>
<td>90</td>
<td>92</td>
</tr>
<tr>
<td>PEP (ms)</td>
<td>89 ± 6</td>
<td>88 ± 5</td>
</tr>
<tr>
<td>PEPc (ms)</td>
<td>124 ± 4</td>
<td>126 ± 4</td>
</tr>
<tr>
<td>ET (ms)</td>
<td>283 ± 10</td>
<td>287 ± 11</td>
</tr>
<tr>
<td>ETC (ms)</td>
<td>410 ± 11</td>
<td>427 ± 5</td>
</tr>
<tr>
<td>AT (ms)</td>
<td>119 ± 0</td>
<td>106 ± 6*</td>
</tr>
<tr>
<td>AT/ET</td>
<td>0.42 ± 0.02</td>
<td>0.36 ± 0.02*</td>
</tr>
<tr>
<td>PEP/AT</td>
<td>0.82 ± 0.06</td>
<td>0.94 ± 0.07*</td>
</tr>
<tr>
<td>PEP/ET</td>
<td>0.32 ± 0.02</td>
<td>0.31 ± 0.02</td>
</tr>
</tbody>
</table>

Values are mean ± standard error of the mean.
* p <0.04 for proximal valve vs distal valve; † p <0.04 for proximal valve vs midway MPA.
AT = acceleration time; ET = ejection time; ETC = heart rate-corrected ejection time; HR = heart rate; MPA = main pulmonary artery; PEP = preejection period; PEPc = heart rate-corrected preejection period.

Invasively. Chan et al\(^2\) showed that the measurement of the peak velocity of the tricuspid regurgitant jet was the most useful and practical technique, but they could obtain the jet in only 72% of the patients studied. Therefore, Doppler techniques other than measurement of the tricuspid regurgitant jet must be used to estimate pulmonary artery pressure in some patients.

Several different RV systolic time intervals have proved useful for estimating pulmonary artery pressure noninvasively.\(^1-8\) Of these intervals, the acceleration time and ratios involving the acceleration time have correlated best with catheterization measurements of pulmonary pressure and vascular resistance.\(^1,6,7\) Systolic time intervals are influenced by factors such as heart rate, contractility, ventricular loading conditions and drug therapy. Therefore, they are limited in their ability to evaluate pulmonary hypertension. In this study, we found that technical factors such as the position of the Doppler sample volume can also influence the noninvasive measurement of RV systolic time intervals.

Different investigators have used different Doppler sampling sites to evaluate patients with pulmonary hypertension. It is as yet unknown which site provides the best correlation with catheterization measurements of pulmonary artery pressure and resistance. In the meantime, if Doppler measurements of acceleration time or ratios involving acceleration time are used to predict pulmonary artery pressure, care must be taken to standardize sample volume position.