CORRELATION BETWEEN INSTANTANEOUS PRESSURE GRADIENT CURVE AND ENVELOPE OF THE HEART SOUND

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The curve of instantaneous (at intervals of 0.02 sec) pressure gradients between the communicating chambers of the heart is the envelope of the heart sound. This indicates that it is proportional to the curve of instantaneous blood flow velocities in this part of the system. Hence it follows that the higher the pressure gradient, the higher the velocity of the blood flow and the greater the amplitude of oscillations on the phonocardiogram.

KEY WORDS: heart defects; heart sounds.

Despite attempts [1, 2, 6, 7] to create a theory of heart sounds, the genesis of the heart sound still remains unexplained and mainly a matter for conjecture [3-5].

To study the problem of the genesis and informative value of the heart sound, curves of the pressure in the right ventricle recorded in patients with a ventricular septal defect during diagnostic cardiac catheterization were compared with the phonocardiograms (PCGs).

EXPERIMENTAL METHOD

The pressure curves were recorded in 152 patients with leakage of blood from the left ventricle into the right and synchronized with recording of PCG and ECG. In synchronized cycles of the pressure curves of the left and right ventricles the pressure gradients (PGs) were calculated in mm Hg at minimal time intervals (usually 0.02 sec) to give instantaneous pressure gradients. The values obtained were plotted (ordinate) against the time of the cardiac cycle, divided into 0.02-sec intervals (abscissa).

EXPERIMENTAL RESULTS

Tiny indentations on the curve of right ventricular pressure could be seen visually in the phase of expulsion (Fig. 1a). In patients with no pathological leakage of blood into the right ventricle the curve of pressure in it was always smooth and almost completely free from these small oscillations, especially in the phase of expulsion of blood (Fig. 1b).

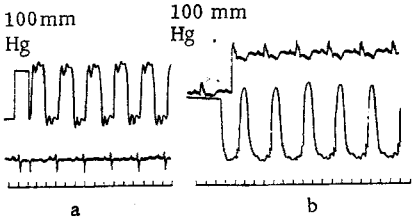

Fig. 1. Curve of right ventricular pressure: a) ventricular septal defect; b) pulmonary stenosis.

Comparison of the instantaneous pressure gradient curve with the PCG showed that the curve is the envelope of the heart sound (Fig. 2). Whatever the reason for this, the envelope of the sound was proportional to thecurve of instantaneous velocities of the blood flow. Hence it follows that the higher the pressure gradient and the higher the blood flow velocity, the greater the amplitude of oscillations on the PCG. In other words, the greater the range of change of instantaneous pressure gradients during the cardiac cycle, the louder the sound recorded on the PCG.

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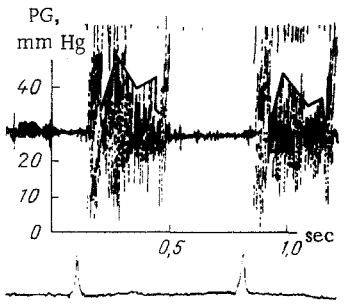

Fig. 2. PCG with superposed envelope of heart sound.

If the pressure gradient between, for example, the left and right ventricles is zero (and the rate of blood flow from one ventricle to the other through the pathological opening is also zero), no heart sound is produced. This happens when the pressure in the right ventricle is sharply increased in patients with ventricular septal defect. In such cases the defect becomes "aphonic" in type.

The heart sound in defects of the heart thus arises when a pathological leakage of blood takes place from one part of the cardiovascular system into another; its loudness is proportional to the pressure difference causing the leakage of blood, and the envelope of the heart sound on the PCG corresponds to the dynamics of the pressure gradients between the communicating cavities during the cardiac cycle.

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