Study of postoperative left ventricular function with and without residual pulmonary stenosis

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Subsequent to the performance of open-heart surgery in children, a comprehensive assessment of the left ventricular function at the time of loading is extremely important to the performance of rehabilitation. However, with regard to the methods of performing loading tests in children, and especially in suckling infants, it is often difficult to carry out a comparative physiological treadmill exercise test, and the reproducibility of the results is also poor. Accordingly, we have made use of a pacemaker electrode which we employ during surgery, and we have divided the postsurgical patients into two groups: group I; consisting of patients with post-surgical residual pulmonary stenosis (PS cases), and group II; consisting of patients with no residual pulmonary stenosis (non-PS cases). After surgery, while pacing load was carried out, echocardiography was employed to investigate the function of the left ventricle.

The subjects of this study were 15 children, varying in ages from 1 to 8 years, who underwent open-heart surgery in the authors' department. Their diseases were diagnosed as tetralogy of Fallot in 2 cases, atrial septum defect (ASD) or ventricular septum defect (VSD) with pulmonary stenosis in 5 cases, pulmonary stenosis in one case, VSD with TCRV in 2 cases, VSD with mPA banding in one case and 1-TGA with VSD and right PS in one case (Fig. 1). The 5 patients with residual PS were placed in group I, while the other 10 patients without PS were placed in group II.

The procedure was as follows. During the open-heart surgical operation, 4 pacemaker wires were implanted, two in the right atrium and the others in the right ventricle. Approximately one month after the operation, prior to discharge the hospital, the spontaneous heart rate at rest was measured as the control value. Then, by means of right atrial or A-V sequential pacing, the heart rate was increased over the control value by 25, 50, 75% and 100%. At each point, the blood pressure (BP) was measured, echocardiography was carried out (M mode) and recorded, and measurements were made of the stroke volume (SV), cardiac output (CO), ejection fraction (EF) in the left ventricle, fractional shortening (FS) in the left ventricle, and the mean velocity of
Fig. 1 Changes of blood pressure, stroke volume, cardiac output and LVEF during pacing load at two groups.

Blood Pressure

Stroke Volume

Cardiac Output

LVEF

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In the control state, the following values were obtained: BP; 105/64±5.1 mmHg (mean) in group I and 108/68±8.6 mmHg (mean) in group II, SV; 16±2.1 ml (mean) in group I and 19±2.3 ml (mean) in group II, CO; 1.5±0.17 l/min (mean) in group I and 1.6±0.24 l/min (mean) in group II, EF; 40% or higher in all cases in both group I and II (Fig. 1), %FS; 41±5.6% (mean) in group I and 43±9.3% (mean) in group II, and mean Vcf; 1.2±0.13 circ/sec (mean) in group I and 1.3±0.17 circ/sec (mean) in group II (Fig. 2). It can be seen from the above results that the values for each of the parameters were slightly lower in group I than in group II. However, the differences between the two groups were not statistically significant.

At the time of pacing load, group I showed a tendency for a decrease in the %FS and mean Vcf under 50% pacing load, and at 75% and 100% loads the decreases in each
parameter were statistically significant (Fig. 2). On the other hand, in the case of the non-PS patients in group II, at pacing loads up to 75% the value for CO increased nearly proportionally to the increase in the heart rate (Fig. 1). The other measured parameters showed no statistically significant decreases.

There are various types of exercise tests in use: for example, the Master two-step test, bicycle ergometer test, treadmill test, etc\textsuperscript{1-3}. However, there are quite a few numbers of problems encountered in applying these tests to young children. In the present research, the subjects were patients in the special situation of having undergone open-heart surgery, and pacing load\textsuperscript{19} studies were carried out on them employing the temporary pacemaker wire which had been used during the surgery. It was found that this method is very useful\textsuperscript{19} because it can be used in patients of all ages, even though it involves some slightly non-physiological aspects in comparison with the treadmill test.

In the 9 non-PS patients, that is, the patients in whom the intracardiac repair was complete, no statistically significant decreases in the functions of the left ventricle were seen when pacing load was performed using up to a 75% increase in the resting state heart rate. This was true regardless of the type of disease.

On the other hand, the decreased left ventricular functions was noted in 50% pacing loaded study, while decreased of functions in various parameters were noted in 75% pacing loaded study in five cases of PS patients. Based on the study using pacing loaded method, it is concluded that the appropriate amount of exercise is estimated up to 50% increase of heart rate in resting stage.

References

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