Long-term Results Following Surgical Operation of Tetralogy of Fallot

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TOTAL correction of tetralogy of Fallot can be achieved with a low mortality rate and with gratifying clinical results. It is necessary to evaluate postoperative state from the standpoint of electrophysiology and hemodynamics. A complete understanding of the problems following corrective surgery for tetralogy of Fallot will lead to more rational and effective therapy.

MATERIALS AND METHODS

(1) Electrocardiogram (ECG)

The ECGs of 84 patients who underwent surgical correction of tetralogy of Fallot were reviewed. This number represents all patients surviving surgery at Kyoto University Hospital from April, 1964 to April, 1974, in whom adequate pre- and postoperative ECGs were available. Complete right bundle-branch block (CRBBB) was diagnosed when the duration of the QRS was 0.12 sec or longer and when a terminal conduction delay was found. Incomplete RBBB (ICRBBB) was considered to be present when the QRS duration was 0.10 to 0.11 sec. Combined RBBB and left anterior hemiblock (CRBBB-LAH) was diagnosed when, in addition to the presence of CRBBB, the mean frontal QRS axis was found to be superiorly oriented, between −60° and −120°, with a Q1Sv3 pattern.

(2) Vectorcardiogram (VCG)

Nineteen patients who showed CRBBB on ECG after corrective surgery for tetralogy of Fallot were studied vectorcardiographically using Frank lead system. The maximum leftward and rightward forces projected on the X axis were termed Rx and Sx respectively (Fig. 1) and their ratio Rx/Sx were measured. These results were compared with those in 12 CRBBB patients without organic heart disease.

Fig.1. Measurements of the QRS loop in the transverse plane.

(3) Cardiac Catheterization

Left ventricular end-diastolic volume (LVEDV) and left ventricular ejection fraction (LVEF) were quantified in 27 patients, 2 months to 10 years (mean 2.7 years) after corrective surgery for tetralogy of Fallot. The ages at the time of the postoperative study ranged from 2 to 29 years (mean 7.8 years) and the ages at surgery from 6 months to 28 years (mean 5.2 years). The results were compared with those in 15
control patients without organic heart disease. The method has been previously published in detail1 The LV pressures of 8 of the above-mentioned 27 patients were recorded by a catheter-tip micromanometer and were processed with a digital computer. V CE and Vmax were calculated by the method of Mason et al2 Normal values for isovolumic phase indices were derived from a study of 8 patients without heart disease.

RESULTS

(1) Electrocardiogram

Among the 84 ECGs recorded one month after corrective surgery, 65 were found to have CRBBB (77%) (Table I). Five patients (6%) showed CRBBB-LAH. Sudden death occurred in 2 of the 5 patients (40%) with CRBBB-LAH, 6 months and 6 years respectively following surgery. One patient who showed CRBBB died immediately after intramuscular injection. This death was likely to be caused by anaphylactic shock. Forty-two ECGs among the 84 patients which were recorded for the last one year were reviewed. Any progression of CRBBB to CRBBB-

LAH was not found.

(2) Vectorcardiogram

There was no significant difference for the magnitude of the maximum rightward QRS forces projected on the X axis (Sx) between postoperative T/F patients and CRBBB patients without organic heart disease (Fig. 2). However,
TABLE III CORRECTIVE SURGERY FOR TETRALOGY OF FALLOT FROM APRIL 1964 TO APRIL 1979 – POSTOPERATIVE ECG FINDINGS (APRIL 1978 TO APRIL 1979)

<table>
<thead>
<tr>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRBBB only</td>
<td>27</td>
</tr>
<tr>
<td>CRBBB + PVC</td>
<td>1</td>
</tr>
<tr>
<td>CRBBB + LAH</td>
<td>3</td>
</tr>
<tr>
<td>ICRBBB</td>
<td>6</td>
</tr>
<tr>
<td>no RBBB</td>
<td>4</td>
</tr>
<tr>
<td>Complete A-V Block</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>42</strong></td>
</tr>
</tbody>
</table>

![Graph showing LVEDV vs. body surface area](image)

**Fig. 3.** Left ventricular end-diastolic volume (LVEDV) corrected for body surface area as a function of body surface area in patients after corrective surgery. The solid and dashed lines indicate the regression line and two standard deviations of normal. (LVEDV ml/m² = 32.3 (BSA) + 41.4 ± 12.0).

A significant difference was found for the ratio of the leftward to rightward QRS forces (Rx/Sx) between these two groups. Rx/Sx is less than 2.0 in all postoperative T/F patients except one.

(3) **Cardiac catheterization**

The LVEDV corrected for body surface area is shown as a function of body surface area in Figure 3. Below 0.8 m² of body surface area, LVEDV was significantly higher in about half the number of patients with corrective surgery than in the controls. Above 0.8 m² of body surface area, all patients except one had a greatly increased LVEDV. LVEF was significantly depressed in patients with corrective surgery, although there was a considerable overlap with the control group (Fig. 4). Peak dp/dt, Vpm, Vmax were also depressed significantly (Fig. 5).

**DISCUSSION**

(1) **ECG**

The overall incidence of sudden death during at least 5 years period of follow-up was 4%, mortality being highest in those with CRBBB and LAH (40%). The prognostic significance of com-
study, it is apparent that depressed LVEF in addition to increased LVEDV indicates impaired LV performance. Then significantly depressed isovolumic phase indices such as peak dp/dt, Vpm, and Vmax suggest some change in myocardial contractility. The reasons for these LV dysfunction are unclear. Patients who had corrective surgery for tetralogy of Fallot are subjected to neither pressure load nor volume load, but they have histories of decreased LVEF, LVEDV7 and chronic hypoxemia. Krymskii10 described focal fibrosis of the left ventricle and diffuse fibrosis of the right ventricle in tetralogy of Fallot. These LV dysfunction may be related to irreversible histological alterations of the myocardium.

**SUMMARY**

(1) The ECGs of 84 patients who survived corrective surgery for tetralogy of Fallot were reviewed. The overall incidence of sudden death during at least 5 years period of follow-up was 4%, mortality being highest in those with CRBBB and LAH (40%).

(2) The ratio of leftward to rightward QRS forces projected on the X axis (Rs/Sx) is significantly decreased in postoperative T/F patients.

(3) Twenty-seven patients who had corrective surgery for tetralogy of Fallot underwent cardiac catheterization postoperatively. LVEF was mildly, but significantly diminished and LVEDV was increased significantly, while peak dp/dt, Vpm and Vmax were significantly depressed. These findings indicate that patients who had corrective surgery for tetralogy of Fallot have impaired left ventricular function.

**Acknowledgements**

We are indebted to Prof. C. Mori, Shimane Medical University for appropriate advice. Gratitude is also due to Prof. Y. Hikasa and Dr. N. Tatsuta, Dept. of Surgery, Kyoto University for pertinent criticism. We are grateful to Drs. T. Hayashida and T. Ueda for cooperation throughout this work.

**REFERENCES**


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