ANTERIOR MITRAL VALVE ECHO IN PATIENTS WITH ISOLATED VENTRICULAR SEPTAL DEFECT AND WITH TETRALOGY OF FALLOT

TAKASHI OKI, SEIZO SAWADA, KOJI MATSUMURA, AND HIROYOSHI MORI

RECENTLY, ultrasonocardiography (UCG) has become one of the important diagnostic tools for the cardiovascular diseases. In particular, UCG of the mitral valve has provided many valuable informations concerning the pathologic physiology of the valve and has contributed to the diagnosis of varieties of functional and organic abnormalities of the mitral valve. There has been, however, only few reports concerning UCG findings in the ventricular septal defect (VSD). The purpose of this paper is to describe the UCG findings in eight patients with isolated VSD and two patients with tetralogy of Fallot (T/F), especially on the functional changes of the mitral valve echoes.

MATERIALS AND METHODS

Ten patients with ventricular septal defect, including eight patients with isolated ventricular septal defect and two patients with tetralogy of Fallot, were studied. Some clinical data on these patients were listed in Table I. Their ages ranged from 7 to 44 years old with the mean age of 27 years old. Electrocardiograms showed sinus rhythms in nine patients except case 8 who had atrial fibrillation. Of ten patients studied, three (cases 8–10) had cyanosis at rest, and one (case 6) after excessive exercise. The remaining patients, however, had no clinical symptom. Cardiac catheterizations and angiocardioographies were performed in 7 patients. The diagnosis was verified by cardiac surgery in 4 patients.

UCG were recorded by Picker Ultrasonoscope Model 102 utilizing a 2.0-MHz transducer of 13 mm diameter. The recordings were made by taking Polaroid photographs from a storage oscilloscope. The patients were examined in the supine position. The transducer was placed in the fourth intercostal space as close to the sternal edge as possible and then rotated slightly superiorly and medially, that is, the position to obtain the echo of the anterior mitral leaflet.

RESULTS

Fig. 1 showed the two types of the normal patterns of the anterior mitral leaflet echoes. There is one point (F) in type I, and are two points (F and F') in type II between E and A points. In 7 of these 10 patients, the anterior mitral leaflet echoes were abnormal, showing notching or fluttering between F and A points of UCG. Among them notching was observed in two patients (cases 4 and 5) of isolated ventricular septal defects with small left-to-right shunts (Fig. 2). As noted in Figs. 1 and 2, notchings seen in the isolated ventricular septal defect were much higher in amplitude than those occasionally seen in normal subjects with type II pattern of the anterior mitral leaflet echoes. The other 5 patients, two of them were cyanotic tetralogy of Fallot, exhibited the characteristic patterns of fluttering. These echo patterns were illustrated in Figs. 3–7. In these patients except case 8 (cases 6, 7, 9 and 10), the flutterings were of low amplitudes and of high frequencies, but it was of rugged type and of low frequency in case 8. Distortions of the pattern of the fluttering seen

Key Words:
- Ultrasonocardiography (UCG)
- Anterior mitral valve echo
- Ventricular septal defect
- Tetralogy of fallot
- Notching of the anterior mitral valve echo
- Fluttering of the anterior mitral valve echo

(Received on March 27, 1974; Accepted for publication: December 11, 1974)
2nd Department of Internal Medicine, School of Medicine, Tokushima University, Tokushima, Japan

Japanese Circulation Journal Vol. 39, June 1975 657
Fig. 1.

Fig. 2.

Japanese Circulation Journal Vol. 39, June 1975
TABLE I EXAMINED SUBJECTS

<table>
<thead>
<tr>
<th>Case</th>
<th>Sex</th>
<th>Age (years)</th>
<th>Diagnosis</th>
<th>ECG</th>
<th>Cyanosis</th>
<th>Cardiac Catheterization</th>
<th>UCG</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>RV Pressures (mmHg)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L-R shunt (%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Operation</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>F</td>
<td>18</td>
<td>VSD</td>
<td>OSR</td>
<td>—</td>
<td>65/3</td>
<td>+</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>34</td>
<td>VSD</td>
<td>OSR</td>
<td>—</td>
<td>20/4</td>
<td>—</td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>36</td>
<td>VSD</td>
<td>OSR</td>
<td>—</td>
<td>22/6</td>
<td>—</td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td>31</td>
<td>VSD</td>
<td>OSR</td>
<td>—</td>
<td>—</td>
<td>n</td>
</tr>
<tr>
<td>5</td>
<td>F</td>
<td>21</td>
<td>VSD</td>
<td>OSR</td>
<td>—</td>
<td>54/22</td>
<td>—</td>
</tr>
<tr>
<td>6</td>
<td>M</td>
<td>7</td>
<td>VSD</td>
<td>OSR</td>
<td>+</td>
<td>90/0</td>
<td>+</td>
</tr>
<tr>
<td>7</td>
<td>F</td>
<td>16</td>
<td>VSD</td>
<td>OSR</td>
<td>—</td>
<td>17</td>
<td>f</td>
</tr>
<tr>
<td>8</td>
<td>M</td>
<td>36</td>
<td>VSD</td>
<td>Af</td>
<td>+**</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>9</td>
<td>F</td>
<td>44</td>
<td>T/F</td>
<td>OSR</td>
<td>+++</td>
<td>110/0</td>
<td>+</td>
</tr>
<tr>
<td>10</td>
<td>M</td>
<td>27</td>
<td>T/F</td>
<td>OSR</td>
<td>+++</td>
<td>110/18</td>
<td>+</td>
</tr>
</tbody>
</table>


in case 8 were suspected probably due to coexisting atrial fibrillation (Fig. 7).

Two (cases 6 and 10) of the five patients with fluttering were operated upon using the technique of closure of ventricular septal defect and total correction of tetralogy of Fallot. Flutterings between F and A points of anterior mitral leaflet echoes, which were distinctly seen preoperatively, disappeared completely after surgery in these two patients (Figs. 3 and 6).

DISCUSSION

Many studies on the UCG of the congenital heart diseases have been reported. It was surprising, however, that the studies on the UCG in ventricular septal defect were unexpectedly few. At present, the following UCG findings were noticed concerning the anterior mitral valve echoes, and have been used as the diagnostic aids: 1) increase of the velocity of mitral valve motion in patients of VSD with left-to-right shunts, and 2) appearance of notching between F and A points of the anterior mitral leaflet echoes.

In the present study, the most characteristic UCG findings in VSD and T/F were the notching (2 cases) and the fluttering (5 cases) between F and A points of the anterior mitral leaflet echoes. The two patients with notching showed no clinical symptom, and the left-to-right shunt ratio in one of these cases was 23%. From these findings it was suggested that the notching of the anterior mitral leaflet echoes might be one of the UCG manifestations of small VSD with left-to-right shunt. It might be supposed that the notchings were produced by the increased velocity of the blood flow through the mitral valve during diastole. Although such notchings were observed in the normal subjects with type II pattern of UCG of the anterior mitral leaflet echoes, they were much higher in amplitudes in VSD. Flutterings were observed in patients without cyanosis (cases 6 and 7) as well as with cyanosis (cases 8, 9 and 10).

Levin et al. (1967) demonstrated that the right-to-left shunt occurred during diastole when the pressure of the right ventricle equaled that of the left in patients with isolated VSD, thus exhibiting cyanosis. They also showed that the right-to-left shunt could occur transiently during isovolumetric relaxation when the systolic pressure gradient between the both ventricles was maintained from 15 to 30 mmHg.

Moreover, Levin et al. (1966) demonstrated the presence of the right-to-left shunts during early ventricular ejection time from the right ventricle directly into the aorta and during isovolumetric relaxation from the right ventricle to the left ventricle across the ventricular septal defect in patients with moderate degree of tetralogy of Fallot.

Japanese Circulation Journal Vol. 39, June 1975
Fig. 6.

Fig. 7.

Fig. 8.
On the basis of these findings and our present observations, it was supposed that the flutterings of the anterior mitral leaflet echoes in isolated VSD with cyanosis and in cyanotic tetralogy of Fallot were produced by the turbulences of blood flow inside of the left ventricle which were produced by the right-to-left shunt across the defect and the mitral flow during diastole. Flutterings were observed in two patients of VSD without cyanosis, whose right ventricular pressures were suspected considerably high. It was interesting enough that the flutterings disappeared after the closure of the ventricular septal defect in two cases (cases 7 and 10).

Fluttering of the anterior mitral leaflet during diastole may be observed in normal subjects or in cardiac patients other than VSD. The following features would contribute to differentiate the fluttering in VSD or tetralogy of Fallot from these in others.

1) The mitral valve echo in normal subjects with type II pattern occasionally showed fluttering between F and A points. Such fluttering was, however, irregular and indistinct.

2) Fine fluttering in aortic insufficiency resembled closely to that in VSD. The major difference was considered that it was more frequently observed between E and F points in the former (Fig. 8), whereas it was mainly observed between F and A points in the latter.

3) Fluttering seen in atrial fibrillation or flutter was usually of higher amplitudes and lower frequencies than that seen in VSD (Fig. 9). The fluttering was exaggerated by the combination of atrial fibrillation in case 8.

SUMMARY

Eight patients with isolated ventricular septal defect and two patients with tetralogy of Fallot were studied by UCG. Two of these patients showed notchings and five showed flutterings on F-A portions of the anterior mitral leaflet echoes. Fluttering seemed to be recorded more frequently in patients with right-to-left shunts such as cyanotic tetralogy of Fallot.

It was considered that these functional changes of mitral valve echoes during diastole would be caused by the direction and amounts of blood flow across the defect and the velocity and amounts of blood flow through the mitral valve. Fluttering of mitral valve echo during diastole may be observed in normal subjects or in patients with other cardiac abnormalities, such as aortic insufficiency, atrial fibrillation or flutter. Flutterings seen in ventricular septal defect and tetralogy of Fallot are, however, of low

Japanese Circulation Journal  Vol. 39, June 1975
amplitudes and of high frequencies, and are observed mainly between F and A points.

REFERENCES


LEGENDS FOR FIGURES

Fig. 1. Two types of the normal echocardiogram of the anterior mitral leaflet.
Type I: There is only one point (F) between E and A points.
Type II: There are two points (F and F) between E and A points.

Fig. 2. Notchings of the echocardiograms of the anterior mitral leaflet in isolated ventricular septal defect (cases 4 and 5).
Notchings (n) of the mitral valve echoes were observed between F and A points in both cases.

Fig. 3. Fluttering of the mitral valve echogram from a patient with isolated ventricular septal defect (Case 6).
Fine flutterings (f) were observed between F and A points preoperatively, although there was no cyanosis. This characteristic fluttering disappeared after the closure of the defect.
Fig.4. Fluttering of the mitral valve echogram from a patient with isolated ventricular septal defect (case 7).
Fine flutterings (n) were observed between F and A points.

Fig.5. Mitral valve echogram from a patient with cyanotic tetralogy of Fallot (case 9).
There were fine flutterings (f) between F and A points.

Fig.6. Mitral valve echograms from a patient with cyanotic tetralogy of Fallot (case 10). Characteristic flutterings (f) between F and A points were observed preoperatively. This finding disappeared after total correction of tetralogy of Fallot.

Fig.7. Mitral valve echogram from a patient with isolated ventricular septal defect (case 8).
Fine fluttering seen in ventricular septal defect was exaggerated by the combination with atrial fibrillation (f').

Fig.8. Mitral valve echogram from a patient with aortic insufficiency. Fine flutterings (Af) were recorded on the downstroke between E and F.

Fig.9. Mitral valve echograms patients with atrial fibrillation and flutter.
Flutterings (Af and AF) between F and A points in these patients were of lower frequencies than those in ventricular septal defect and in tetralogy of Fallot.