SURGICAL TREATMENT OF VENTRICULAR SEPTAL DEFECT 
AND ITS SEQUELAE IN ADULTS

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We operated on 20 adult patients with ventricular septal defect (VSD). In 7 of these cases (aged 36 to 51 years, average 42.6 years), VSD was accompanied by sequelae other than pulmonary hypertension. Concomitant procedures in type-I VSD included a suspension of the prolapsed aortic cusp in 2 patients, a repair of the ruptured sinus of Valsalva in 2, and a new procedure for active infective endocarditis, described below, in 2. In this latter procedure, the aortic valve and infected Valsalva sinus were excised, and the pulmonary valve and the right ventricular wall to which the infection had extended were thoroughly debrided. The resulting defect was closed with a single patch, and a prosthetic valve was inserted in the position of the original aortic valve using this patch as part of the annulus. Another patient with the type-II VSD underwent concomitant tricuspid valve replacement for infective endocarditis. In the mean follow-up period of 77.1 months, 6 patients have been doing well in New York Heart Association class I, and the remaining patient with Valsalva repair remained in class II due to dilated cardiomyopathy. (Jpn Circ J 1994; 58: 827—830)

VE NTRICULAR septal defect (VSD) is often accompanied by a variety of sequelae other than pulmonary hypertension when left surgically untreated. These sequelae can cause formidable conditions and require intricate surgical repair.

In our institute, 20 adult patients with VSD were treated surgically, and 7 of them underwent concomitant procedures for its sequelae.

Patients (Table I)

From September 1983 to August 1993, 20 adult patients with VSD were operated on at the Hyogo Brain and Heart Center. Of these 20, 6 patients with Kirklín type-I VSD and 1 with type-II VSD showed accompanying sequelae. These 7 patients consisted of 5 men and 2 women, ranging in age from 36 to 51 years (average, 42.6). The sequelae in type-I VSD included prolapse of the right coronary cusp with severe aortic regurgitation in 2 patients, ruptured sinus of Valsalva aneurysm in 2, and infective endocarditis in 2, the causative microorganisms in whom were α-streptococcus and streptococcus faecalis. A patient with type-II VSD was complicated with infective endocarditis caused by α-streptococcus. Cardiac catheterization was performed in 5 patients, and the remaining 2 were diagnosed only by echocardiography because of active infective endocarditis. The pulmonary-to-systemic flow ratio was 1.2 to 4.2 (average, 2.1) and mean pulmonary arterial pressure was 11 to

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TABLE I PREOPERATIVE PROFILE OF VSD WITH ITS SEQUELAE

<table>
<thead>
<tr>
<th>Case</th>
<th>Age</th>
<th>Sex</th>
<th>Qp/Qs</th>
<th>PA (mmHg)</th>
<th>Sequences</th>
<th>NYHA</th>
<th>VSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>40</td>
<td>M</td>
<td>1.7</td>
<td>18/8 (11)</td>
<td>AR</td>
<td>II</td>
<td>type* 1</td>
</tr>
<tr>
<td>2</td>
<td>43</td>
<td>M</td>
<td>1.2</td>
<td>23/13 (17)</td>
<td>AR</td>
<td>II</td>
<td>I</td>
</tr>
<tr>
<td>3</td>
<td>48</td>
<td>M</td>
<td>1.3</td>
<td>70/38 (51)</td>
<td>RSV, DCM</td>
<td>III</td>
<td>I</td>
</tr>
<tr>
<td>4</td>
<td>36</td>
<td>M</td>
<td>4.2</td>
<td>40/21 (28)</td>
<td>RSV</td>
<td>II</td>
<td>I</td>
</tr>
<tr>
<td>5</td>
<td>44</td>
<td>M</td>
<td>-</td>
<td>-</td>
<td>IE, RSV</td>
<td>IV</td>
<td>I</td>
</tr>
<tr>
<td>6</td>
<td>51</td>
<td>F</td>
<td>-</td>
<td>-</td>
<td>IE, RSV</td>
<td>IV</td>
<td>I</td>
</tr>
<tr>
<td>7</td>
<td>36</td>
<td>F</td>
<td>2.3</td>
<td>43/16 (29)</td>
<td>IE</td>
<td>III</td>
<td>II</td>
</tr>
</tbody>
</table>

VSD = ventricular septal defect; Qp/Qs = pulmonary-to-systemic flow ratio; PA = pulmonary arterial pressure; NYHA = New York Heart Association class; AR = aortic regurgitation; RSV = ruptured sinus of Valsalva aneurysm; DCM = dilated cardiomyopathy; IE = infective endocarditis; RSV = ruptured sinus of Valsalva.

*: Kirklin classification.
M = male; F = female

TABLE II SURGICAL PROCEDURES AND POSTOPERATIVE OUTCOMES

<table>
<thead>
<tr>
<th>Case</th>
<th>Surgical Procedures</th>
<th>PA (mmHg)</th>
<th>Follow-up</th>
<th>NYHA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PC, AVP</td>
<td>25/8 (14)</td>
<td>2Y1Mo</td>
<td>I</td>
</tr>
<tr>
<td>2</td>
<td>PC, AVP</td>
<td>14/6 (10)</td>
<td>8Y7Mo</td>
<td>I</td>
</tr>
<tr>
<td>3</td>
<td>PC, Valsalva Repair</td>
<td>30/12 (18)</td>
<td>9Y5Mo</td>
<td>II</td>
</tr>
<tr>
<td>4</td>
<td>DC, Valsalva Repair</td>
<td>18/7 (12)</td>
<td>1Y4Mo</td>
<td>I</td>
</tr>
<tr>
<td>5</td>
<td>PC, Debridement, AVR</td>
<td>16/6 (10)</td>
<td>3Y5Mo</td>
<td>I</td>
</tr>
<tr>
<td>6</td>
<td>PC, Debridement, AVR</td>
<td>30/8 (15)</td>
<td>10Mo</td>
<td>I</td>
</tr>
<tr>
<td>7</td>
<td>PC, TVR</td>
<td>28/11 (18)</td>
<td>8Y2Mo</td>
<td>I</td>
</tr>
</tbody>
</table>

PC = patch closure; DC = direct closure; AVP = aortic valvuloplasty; AVR = aortic valve replacement; TVR = tricuspid valve replacement.
Y = year; Mo = month

51 mmHg (average, 27). The 2 patients with active infective endocarditis in type-I VSD were in preoperative New York Heart Association (NYHA) class IV, 2 with ruptured sinus of Valsalva aneurysm and infective endocarditis, respectively, were in class III, and the other 3 patients were in class II.

Operative Findings and Procedures (Table II)

Surgery was performed using total cardiopulmonary bypass with moderate hypothermia. As a heart protection, retrograde cold blood cardioplegia via the coronary sinus was used in all patients. The 2 patients with a prolapse of the right coronary cusp underwent a suspension procedure in addition to patch closure of the VSDs through the transventricular approach. This suspension procedure was performed at the unilateral commissure of the right coronary cusp in 1 patient and at the bilateral commissures in the other to repair the prolapse completely. In the 2 patients with ruptured sinus of Valsalva aneurysm, the defect resulting from the excision of the aneurysm was directly closed, and direct and patch closure of the VSDs were performed through the transventricular and transpulmonary approaches, respectively. Additional aortotomy was not performed in either case because the boundary between the aortic annulus and the Valsalva aneurysm was clear and it was fairly certain that Valsalva repair would not transform the aortic cusp. The 2 patients with active infective endocarditis, which extended to both sides of the heart with rupture of the infected Valsalva sinus, had bacillus vegetation clinging to the aortic and pulmonary valves and to the right ventricular intimal wall around the VSD. In these cases, the aortic valve and infected Valsalva sinus were excised, and the pulmonary valve and right ventricular wall to which the infection had extended were thoroughly debrided. The resulting defect, including the VSD and excised right Valsalva sinus and aortic annulus, was closed with a single patch, and a pros-
Surgical procedure for type-I VSD with infective endocarditis extending to the Valsalva sinus and aortic annulus.

Surgical Outcome (Table II)

In the follow-up period ranging from 10 to 113 months (mean, 77.1), 6 patients have been doing well in NYHA class I, while the remaining patient with Valsalva repair remained in class II due to dilated cardiomyopathy. Pulmonary arterial pressure was reduced in all cases with preoperative pulmonary hypertension. In the two patients who underwent the suspension procedure, aortic regurgitation has completely disappeared. The 2 patients with Valsalva repair have shown no aortic regurgitation, which can occur as a result of such repair. The 3 patients with infective endocarditis have enjoyed an uneventful course with no recurrence of infection, and in the 2 who were type-I VSD, a persistent pulmonary regurgitation due to a debridement has not affected right ventricular function.

DISCUSSION

Most VSDs close spontaneously during childhood. However, if a patent VSD is left surgically untreated, it may cause a variety of sequelae other than pulmonary hypertension. It is well known that aortic regurgitation is associated with the Kirklin type-I VSD due to prolapse of the right coronary or noncoronary cusp into the VSD. This type of regurgitation is usually treated by a suspension procedure, with a generally good results, as in the two cases in this series. Despite this procedure, however, aortic regurgitation can develop in some patients, and requires aortic valve replacement.

Ruptured sinus of Valsalva aneurysm is also a complication in type-I VSD. Among Orientals, most aneurysms originate from the right coronary sinus and drain into the supracristal right ventricle; so-called Konno classification type I. This association requires an intricate surgical procedure because of the anatomical complexity and sometimes requires an additional aortotomy to determine whether or not the aortic cusp is transformed or not. In 2 cases in this series, aortotomy was not necessary because the boundary between the aortic annulus and the Valsalva aneurysm was clear, and it was fairly certain that Valsalva repair would not transform the aortic cusp. In addition, the recent advent of transesophageal Doppler echocardiography can be very useful in evaluating a residual shunt and such aortic regurgitation intraoperatively. Considering the mechanisms of these sequelae, an earlier closure of the Kirklin type-I VSD may prevent not only a prolapse of the aortic cusp but also a protrusion of the Valsalva sinus, and eventually reduce the incidence of these sequelae.

In this paper, a new procedure was introduced for active infective endocarditis associated with type-I VSD. In these 2 cases, endocarditis extended to both sides of the heart through the VSD, and the aortic valve, pulmonary valve and Valsalva sinus, including the aortic annulus, were involved. A thorough debridement of the infected tissues around the VSD and ruptured Valsalva sinus created a large defect in this area. The defect was closed with a single patch, and the aortic valve was replaced in the position of the original valve using this patch as part of the annulus. This procedure offers the advantages of maintaining the original anatomical configuration along with a radical de-
bridement, as compared with other procedures9,10 such as the translocation procedure.

REFERENCES