Aneurysm of Pericardial Right Ventricular Outflow Tract Patches
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ABSTRACT Among 1,022 patients who underwent repair of tetralogy of Fallot, 252 received a pericardial patch of the right ventricular outflow tract; of these, 10 subsequently developed an aneurysm of the right ventricular outflow tract. Cardiac catheterization and angiography revealed moderate pulmonary insufficiency in all patients, a residual pressure gradient in the right ventricular outflow tract in 7, and a residual ventricular septal defect in 2 patients. Reoperation was indicated in 8 patients because of progressive distention of the aneurysm, residual infundibular or pulmonary artery stenosis, and recurrent ventricular septal defect. Reconstruction of the right ventricular outflow tract was accomplished by resection of the aneurysm and insertion of a woven Dacron patch in 5 patients, primary suture of the pulmonary artery in 2, and implantation of a woven Dacron conduit containing a Bjork-Shiley cardiac valve prosthesis in 1 patient. There were no early or late deaths. When reconstruction of the right ventricular outflow tract is necessary, we recommend a woven Dacron patch because pericardium may form an aneurysm.

Many patients with severe tetralogy of Fallot require patch reconstruction of the right ventricular outflow tract (RVOT). Ivalon resulted in many false aneurysms [2, 6]. Woven Teflon was used often in the early 1960s but was relatively rigid and was often associated with postoperative hemorrhage. After a short period, however, Teflon was superseded by pericardium. At the Texas Heart Institute, pericardial patches have been used since 1964 for reconstruction of a hypoplastic RVOT in patients with tetralogy of Fallot. Some patients later developed aneurysms of the RVOT. We present our current experience with this rare complication.

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had a pressure gradient in the RVOT ranging between 15 and 50 mm Hg. The location of the pressure gradient was identified in the supravalvular level or at the bifurcation in 5 patients and was caused by residual infundibular stenosis in 2.

A residual VSD with a flow ratio of 2:1 was found in 2 patients. One of these, as described earlier, had limited activity and shortness of breath on moderate exertion. The resistance ratio in this patient was calculated at 0.29, indicating peripheral pulmonary vascular obstructive disease. Moderate pulmonary regurgitation was present in all patients. Angiography, performed in 8 patients, revealed a large aneurysm of the RVOT (Figure).

**Surgical Treatment**

Operation was deemed unnecessary in 2 patients who demonstrated slowly progressing dilatation of the pulmonary artery on serial roentgenograms. In the remaining 8 the indications for correction were progressive distention of the aneurysm (8), recurrent VSD (2), residual infundibular stenosis (2), and residual pulmonary artery stenosis (5) (Table 1).

A midsternal approach was used in all 8 children. Extensive adhesions between the pericardium and the heart were incised carefully and only as far as necessary for cannulation. Cardiopulmonary bypass was initiated before the aneurysm of the pulmonary artery was dissected. In 1 patient the aneurysm was attached to the sternum, and femoral cannulation was used prophylactically.

In most patients the pericardial patch proved to have ballooned out and was extremely friable. False aneurysms were found in 2 patients. After
Table 1. Indication for Resection of an Aneurysm of the Right Ventricular Outflow Tract in 8 Patients

<table>
<thead>
<tr>
<th>Indication</th>
<th>No. of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Progressive distention alone</td>
<td>1</td>
</tr>
<tr>
<td>Progressive distention and infundibular stenosis</td>
<td>2</td>
</tr>
<tr>
<td>Progressive distention and pulmonary stenosis</td>
<td>3</td>
</tr>
<tr>
<td>Progressive distention, pulmonary stenosis and VSD</td>
<td>2</td>
</tr>
</tbody>
</table>

VSD = ventricular septal defect.

Resection of the aneurysm, the RVOT was reconstructed with a large woven Dacron patch in 5 patients. In 4 patients the patch extended past the bifurcation of the pulmonary artery, relieving peripheral pulmonary artery stenosis. In 1 of these patients the ascending aorta was transected, and a long woven Dacron patch, extending from the right pulmonary artery across the bifurcation to the left, was inserted. The aorta was then reanastomosed, and the main pulmonary artery and right ventricle were sutured primarily after excision of the aneurysm. In 3 patients the pulmonary artery was dilated. In 2 of these patients the pulmonary artery and outflow tract could be sutured primarily after excision of the aneurysm. The third patient also had a residual shunt and peripheral pulmonary vascular disease; therefore, the main pulmonary artery was replaced with a woven tube graft containing a Björk-Shiley valve (Table 2). In 2 patients a recurrent VSD was closed with a knitted Dacron patch.

Microscopical studies in 4 patients revealed sclerosis and calcification of the aneurysmal pericardium. Chronic inflammation was present in 1 patient.

Results

All patients survived operation, and no major postoperative complications occurred. Of the 8 patients treated surgically, 7 are doing well. The 1 child who received an RVOT conduit is in Class II according to the New York Heart Association Functional Classification. Repeat cardiac catheterization of this patient one year post-operatively revealed stenosis of the valve conduit with a gradient of 50 mm Hg.

Comment

Following surgical repair of tetralogy of Fallot, the most common late complications are a recurrent (or residual) VSD and a residual pressure gradient across the RVOT [6]. The incidence of aneurysms of the RVOT after repair with pericardial patches is reported to range between 6 and 25% [2, 3, 8]. Among our series of 252 patients who received a pericardial patch of the RVOT, 10 patients (4%) developed aneurysms.

The size of the pericardial patch is considered one of the etiological factors in the formation of the aneurysm. Hawe [2] reported a high incidence (18%) when a large pericardial patch was used and observed a reduced occurrence, to less than 2%, when smaller, teardrop-shaped pericardial patches were applied. In our patients all aneurysms developed after large pericardial patches were placed across the pulmonary annulus—some extending to the bifurcation of the pulmonary artery.

Similar to other investigators [5, 6, 8], we noted a close correlation between formation of an aneurysm of the RVOT and obstruction of the RVOT or an overload of the right heart due to a residual shunt. Five of our patients had peripheral pulmonary artery stenosis and 2 had residual infundibular stenosis. In 2 patients a residual VSD was present, creating an overload of the right side of the heart. All patients had
pulmonary valve insufficiency. No aneurysm of a pericardial patch occurred in our patients who underwent reconstruction of the pulmonary artery after pulmonary artery debanding. In these patients there usually is no pulmonic insufficiency and no circulatory overload. Kawashima and associates [4] demonstrated that a high pressure gradient does promote formation of an aneurysm of a pericardial patch used to close a VSD.

Some authors have said that true pericardial aneurysms tend to stabilize [2, 3, 8]. Our experience does not confirm this. Six of our patients with surgically treated RVOT aneurysms had true aneurysms with progressive distention. Surgical exploration revealed that they were friable. In 2 patients the pericardial patch had expanded to the extent that little of it could be identified at operation. Furthermore, the angiographic distinction between a false and true aneurysm may be difficult. Although no rupture of such an aneurysm has been reported, our policy is to explore and resect every aneurysm of the RVOT showing progressive distention.

In 1972, to prevent the rare complication of formation of an aneurysm of the RVOT, we abandoned the use of pericardium for reconstruction of a hypoplastic RVOT. We now use woven Dacron cloth. This material can be trimmed easily. Fraying of the woven material is avoided by tailoring the patch with an electric cautery (Accu-Temp).* Since using woven Dacron patches, we have not encountered an aneurysm of the RVOT.

*Concept, Inc, Airport Station, St Petersburg, FL 33732.

References