Percutaneous Treatment of Atrial Septal Defects, Muscular Ventricular Septal Defects and Patent Ductus Arteriosus in Infants Under One Year of Age

Fredy Prada, Carlos Mortera, Joaquim Bartrons, Miguel Rissech, Lorenzo Jiménez, Juan Carretero, Judit Llevadias, and Mireya Araica

INTRODUCTION

Amplatzer devices are used in the percutaneous closure of ostium secundum atrial septal defects (OS-ASD),1 patent ductus arteriosus (PDA),2 and muscular ventricular septal defects (m-VSD).3 They are safe and entail little risk and this has led to their widespread use in adult and pediatric patients, but little is known of their use, effectiveness and safety in patients aged <1 year.4,5

METHODS

We conducted a retrospective review of children aged <1 year diagnosed with OS-ASD, PDA, or m-VSD, who underwent percutaneous closure procedures in our hospital between January 2001 and January 2008. We did not treat children with perimembranous VSD because these devices entail a risk of complete atrioventricular block, as recently confirmed for ≤5% of patients.6

For each defect type, we used the techniques described in the literature for older children and adults.1,3,7 In all patients, we used general anesthesia; in patients with OS-ASD or m-VSD we also used transesophageal echocardiography.

The Fick method was used to calculate the Qp/Qs. We chose an appropriate device according to the defect diameter; in patients with OS-ASD, a sizing balloon was used to establish the stretched...
diameter of the OS-ASD, in ductus arteriosus, we measured at the pulmonary end in lateral aortic angiography; in m-VSD, diameter was estimated using echocardiography and/or the ventriculography in the left oblique projection. We employed nitinol-filament, self-expanding Amplatzer devices (AGA Medical Corporation, Golden Valley, Minnesota, USA) that have thermal memory and can be deployed in a controlled manner.

We recorded demographic, clinical and hemodynamic data, procedure duration recorded as radioscopy time, results, and immediate and late complications. Data are expressed as mean (range).

RESULTS

We treated 22 children aged <1 year with symptoms of OS-ASD, PDA or m-VSD (Table 1). Clinical indications, hemodynamic variables (Qp/Qs and AP/AO systolic pressure ratio), defect diameter and devices employed are in Table 2.

Radioscopy times for OS-ASD, PDA and m-VSD were 23.7 (13-40), 21.5 (6-60), and 44 (34-57) min, respectively.

All procedures were successful. We had no acute or late complications during follow-up of 18.7 (5.5-38.3), 34 (5.7-90.9), and 44.1 (20-65.2) months for OS-ASD, PDA, or m-VSD respectively.

DISCUSSION

Atrial Septal Defects

Most children with OS-ASD have few symptoms and surgery is generally indicated at pre-school age,8 although some require earlier treatment. It is reported that OS-ASD tend to grow with time.9 The group of children susceptible to early treatment includes those at greatest risk of progressing to irreversible pulmonary hypertension.10 For example, patient 1, with Down’s syndrome, presented severe pulmonary hypertension with AP/AO ratio=1. His pulmonary pressure was normal at 1 year post-procedure. In patient 2, repeated respiratory complications were observed.

We observed no peripheral vascular complications attributable to surgery or administration of heparin and/or thrombolytic agents.

TABLE 1. Demographic Characteristics

<table>
<thead>
<tr>
<th>Defect Type</th>
<th>No.</th>
<th>Boys/Girls</th>
<th>Age, Months</th>
<th>Weight, kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>OS-ASD</td>
<td>3</td>
<td>0/3</td>
<td>8 (3.2-11.3)</td>
<td>6.6 (4.9-8.8)</td>
</tr>
<tr>
<td>PDA</td>
<td>15</td>
<td>7/8</td>
<td>6.6 (1.9-11.1)</td>
<td>6.7 (3.7-8.9)</td>
</tr>
<tr>
<td>m-VSD</td>
<td>4</td>
<td>1/3</td>
<td>6.1 (4.8-8.6)</td>
<td>5.6 (4.4-6.9)</td>
</tr>
</tbody>
</table>

m-VSD indicates muscular ventricular septal defect.
Age and weight expressed as mean (range).
infections, failure to thrive or high Qp/Qs indicated the treatment. Patient 3 (Figure 1), with congenital complete atrioventricular block without indication for pacemaker, had moderate pulmonary hypertension with AP/AO systolic pressure ratio =0.73 during cardiac catheterization. At 6 months, echocardiography showed normal pulmonary pressure. These 3 patients had specific indications for OS-ASD closure and we opted for percutaneous treatment to avoid the inconveniences of surgery. In the only series published in this age-group, OS-ASD required closure with hybrid procedures in 21% of children; although our group is small, we have not needed to employ this technique.

During follow-up (mean, 18.7 months), we found no late atrial wall perforation. A review of this rare complication found it occurs ≤3 years post-procedure. Patient age or weight were not risk factors. Both mismatching defect and device diameters and anterosuperior defect location have been suggested as risk factors for late of perforation.12

Persistent Ductus Arteriosus

PDA closure was indicated in all four patients because of excessive pulmonary blood flow. In patients 5 and 8, Qp/Qs may have been overestimated due to incorrect blood sampling in the pulmonary artery; however, PDA diameters were 2.5 and 3.2 mm respectively. Patient 4 (Figure 2) was a 40 days old infant girl, with a non-obstructive total abnormal pulmonary veins drainage into coronary sinus and superior vena cava. During cardiac catheterization we found suprasystemic pulmonary hypertension (AP/AO systolic pressure ratio =1.15) and 1.6 mm
As large as 7 Fr Mullins sheaths in the femoral vein (patients 9 and 14).

**Muscular Ventricular Septal Defects**

In a series of 20 children aged <1 year, Diab et al. reported 30% needed a hybrid procedure. In our 4-patient series, none required this. Patient 22, a girl with type I truncus arteriosus, double VSD (one of them muscular apical), had neonatal pulmonary banding. We decided to close the apical m-VSD first because surgical m-VSD closure entails high morbidity and mortality, especially when the location is apical, and the surgical approach may need to be from the left ventricle, with the consequent damage to ventricular function.

**Risk of Vascular Lesion**

Amplatzer deployment sheaths require venous access and are commercialized by internal diameter size. The largest diameter we used was 7 Fr (patients 2, 3, 9, and 14). In patients with m-VSD...
(Figure 3), we used 6 Fr sheaths via the internal jugular vein. We believe possible vascular damage caused by such thick sheaths can be minimized by careful handling.

REFERENCES


