Transcatheter Device Closure of Muscular Ventricular Septal Defect

Yun-Ching Fu a,b,c,*

a Department of Pediatrics, Lin-Shin Hospital, Taichung, Taiwan
b Department of Pediatrics, Taichung Veterans General Hospital, Taichung, Taiwan
c Department of Pediatrics, National Yang Ming University, Taipei, Taiwan

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Muscular ventricular septal defects (VSDs) account for 10–15% of congenital VSDs and can be single or multiple, existing anywhere in the septum. The most common form of muscular VSDs is the apical defects, followed by the mid-muscular defects. Anterior defects are less common, and multiple muscular VSDs (Swiss cheese muscular septum) are rare. Acquired muscular VSDs are very rare and usually caused by acute myocardial infarction or, occasionally, by trauma. When the defect is large enough to have hemodynamic significance, closure of the defect is indicated. Traditional treatment is surgical closure, but it carries considerable morbidity and mortality, primarily resulting from technical difficulties associated with inadequate exposure and incomplete closure. In some cases, a left ventriculotomy is needed, which may cause left ventricular impairment, apical aneurysm, or ventricular arrhythmia. Moreover, the surgical scar may be a cosmetic concern for the patients and their parents.

Transcatheter closure of muscular VSD was first reported by Lock et al4 in 1987 using a Rashkind umbrella device. Since

* Corresponding author. Department of Pediatrics, Taichung Veterans General Hospital, 160, Section 3, Chung-Kang Road, Taichung 40705, Taiwan.
E-mail address: ivanfu@vghtc.gov.tw.

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then, there have been several devices developed, including the Sideris buttoned device, Gianturco and detachable coils, and others. However, these devices were not originally designed for this purpose, and their widespread use has been limited by several drawbacks, such as large delivery sheaths, complex implantation techniques, inability to recapture and reposition and a high rate of residual shunts.

The Amplatzer Muscular VSD occluder (AGA Medical Corporation, Plymouth, MN, USA) was approved by the US Food and Drug Administration in September 2007 and by the Taiwan Department of Health in September 2009. It is a self-expandable double-disc device made from a nitinol wire mesh.1–3,7–9 Dacron polyester patches are sewn into each disc and the connecting waist to increase the thrombogenicity of the device. The device is symmetric, specifically designed for the muscular VSD. Both the left ventricle retention skirt and the right ventricle retention disk are 4 mm larger than the waist. The connecting waist is 7-mm wire mesh.1

The procedure is preferably performed under general endotracheal anesthesia with transesophageal echocardiographic guidance.1–3,7–9 Left ventriculography in the left anterior oblique view defines the location and size of the VSD. Balloon sizing is not suggested as it carries a certain risk, and it may not be useful for a nonstretchable muscular interventricular septum. The appropriate device size is chosen to be the same or 1–2 mm larger than the VSD size, measured by transesophageal echocardiographic guidance or ventriculography. The standard closure procedure is as follows: A 4 or 5 French Judkins right (Terumo Medical Corp., Somerset, NJ, USA) or Cobra catheter (Cook Medical, Bloomington, IN, USA) is used to guide an exchanged-size Terumo glide wire across the defect into the right ventricle and then the pulmonary artery or superior vena cava. Subsequently, the wire is snared and gently pulled out into the right internal jugular or femoral vein. A long delivery sheath is then passed over the wire from the vein, across the defect and then entering the left ventricle. The dilator and the wire are then removed, and the device is loaded and deployed. Patients are sent home on the day after the procedure and take aspirin 3–5 mg/kg daily for 6 months. If the infant is small in size (<4 kg), precluding safe percutaneous closure, or if the VSD is associated with other defects requiring open surgical repair, closure of the VSD can be achieved percutaneously in the operating room before initiation of cardiopulmonary bypass (hybrid therapy).

The results of initial human experiences are encouraging.7–9 In 2004, the United States registry of the Amplatzer Muscular VSD occluder reported 83 procedures in 75 patients with a median age of 1.4 years, who underwent percutaneous (70 of 75) and/or pereventricular (6 of 75) closure of hemodynamically significant congenital single or multiple muscular VSDs. The device was implanted successfully in 72 of the 83 (86.7%) procedures. Major procedure- or device-related complications occurred in 10.7% of the patients. Closure rates were excellent and increased from 47.2% 24 hours post-procedure to 92.3% at 12 months’ follow-up. These results compare favorably with the surgical results. In 2005, Thanopoulos reported intermediate-term outcome in 30 children with single muscular VSD.2 Successful closure of the defect was achieved in 28 of the 30 patients (93%). Major complication was noted in only one patient (4.2 kg) who developed a complete heart block. In 2004, the U.S. registry of the postinfarction muscular VSD occluder reported on 18 patients.11 The procedure was successful in deploying a device across the VSD in 16 of the 18 patients. The 30-day mortality was 28%. Eleven patients are still alive and have been followed up for a median of 332 days.

In conclusion, transcatheter closure of muscular VSDs using the Amplatzer muscular VSD occluders is effective and safe. It has no scar, less pain, shorter hospital stay, and less cost compared with the traditional open heart surgery.

References