Atrioventricular Block: A Serious Complication in and After Transcatheter Closure of Perimembranous Ventricular Septal Defects

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ABSTRACT

Background: Transcatheter closure is an effective approach for perimembranous ventricular septal defects (PMVSD). However, atrioventricular blocks (AVB) emerged possibly due to the close proximity of the PMVSD to the conduction system, but concern for the complication was not adequately emphasized. In this study, we report the incidence of AVBs, in and after transcatheter closure of a PMVSD, and the outcome of the complication in our center.

Methods: One hundred and sixty-eight PMVSD patients were accepted for transcatheter closure with Amplazter PMVSD occluder (AGA Medical, Plymouth, Minn., USA). The procedure was discontinued when a second- or third-degree AVB occurred. A steroid was administered to all patients who developed AVBs. Temporary pacemakers were inserted in patients who developed a complete AVB or Mobitz type II AVB during or after the procedure.

Results: During the follow-up period of 6–24 mo (mean 10.6 ± 3.9), the incidence of AVBs occurring during or after transcatheter closure of PMVSD was 3.5%. The AVB disappeared quickly after discontinuing the procedure in patients who developed AVBs during the procedure, whereas the AVBs disappeared between 2 and 21 d (mean 8.0 ± 8.8) in the patients who developed AVBs after the procedure. However, complete right bundle branch block (CRBBB) was observed, and a transient complete AVB emerged after 8 mo in 1 case, incomplete right bundle branch block (IRBBB) in 1 case, and CRBBB and left anterior hemiblock (LAH) in 1 case.

Conclusions: The AVB is a serious complication during and after transcathter closure of PMVSD. More attention should be paid to the complication, and multicentres are required to monitor the complication.

Key words: atrioventricular block, catheterization, ventricular septal defect, complication

Introduction

The technique and feasibility of transcatheter closure of a perimembranous ventricular septal defect (PMVSD) were confirmed by using Amplatzer septal occluders (AGA Medical, Plymouth, Minn., USA) in many centers.[1–4] Preliminary results following the use of this device were encouraging, and the incidence of complications such as aortic and tricuspid regurgitation was low.[1,2,5] However, the complication of atrioventricular block (AVB) emerged due to the close proximity of a PMVSD to the conduction system.[6,7] In this article, we report the incidence of AVBs during and after transcatheter closure of PMVSD with the Amplazter eccentric PMVSD occluder, and the outcome of the complication in our center.

Patients and Methods

A group of 168 PMVSD patients (72 male and 96 female, mean age 14.8 ± 7.2 y old, median 13.1) were accepted for transcatheter closure from October 2002 to February 2007 in our center. Only in those patients with PMVSD diameters from 3 to 18 mm, the distance of the upper PMVSD rim to the aortic valves leaflet; at least 1 mm on transthoracic echocardiography (TTE); and clinical and/or echocardiographic evidence of a significant left-to-right shunt were selected. Aneurysm of the perimembranous septum was present in 45 patients. Three cases were associated with patent ductus arteriosus (PDA), 2 cases were associated with atrial septal defect (ASD), and 1 case with anomalous inferior vena cava drainage. The diameters of the VSDs ranged from 3 to 18 mm (5.8 ± 3.7, median 6.2) by TTE. Incomplete right bundle branch block (IRBBB) was found in 5 cases. The ratio of pulmonary to systemic blood flow ranged from 1.2 to 3.7 (2.0 ± 0.6, median 1.9). All patients were hospitalized and informed consent was obtained from each patient or the guardian.

Clin. Cardiol. 31, 8, 368–371 (2008)
Published online in Wiley InterScience. (www.interscience.wiley.com)
DOI:10.1002/clc.20243

Received: May 12, 2007
Accepted with revision: July 3, 2007

The PMVSD closure was performed under local anesthesia or with general anesthesia in small children. An electrocardiogram monitor was used throughout the procedure. All patients underwent right and left cardiac catheterization through the percutaneous transfemoral route. The left anterior oblique view that best profiled the VSD was determined and cineangiography was performed. Transthoracic echocardiographic imaging was performed in all patients simultaneously. The size of the VSD and its distance from the aortic and tricuspid valves were reconfirmed. The sizes of the devices were selected to be 1–2 mm larger than the diameter of the defect as assessed by angiocardiography. Heparin (100 units/kg) and antibiotics were administered to all patients before the procedure. The transcatheter closure of the PMVSD was carried out as per the standard procedure.[8–10] The procedure was discontinued when the second- or third-degree AVB occurred. Dexamethasone (2 mg/kg) was administered to the patients immediately, and a temporary pacemaker was inserted when Mobitz type II AVB, or complete AVB, occurred during the procedure. After the procedure, all patients were monitored by telemetry monitoring for 3 consecutive d in the intensive care unit. Aspirin (5–6 mg/kg/d) was administered to all patients and intravenous dexamethasone (1 mg/kg/d) was given to the patients who developed AVB after the procedure. If complete AVB persisted for more than 5 d, prednisone (1 mg/kg/d) was substituted for dexamethasone and an H2-receptor antagon, such as ranitidine or famotidine, was administered simultaneously. A temporary pacemaker was used until the AVB was resolved.

Results

Atrioventricular blocks occurred in 2 cases during the procedure and in 4 cases after the procedure, and the total incidence was 3.5%. Mobitz type II AVB emerged in 1 case when the arteriovenous loop was created, and a complete AVB occurred in the other patient when the occluder was deployed in the septum. The AVB disappeared quickly after discontinuing the procedure in 2 cases, but dexamethasone (1 mg/kg/d) was still administered for 3 d. After 1 mo, the patients were accepted for surgical repair, but their parents refused to accept the same procedure again. The onset of AVB occurred from 23–76 h (mean 53.8±22.7) after the procedure in 4 cases, and disappeared after 2–21 d (mean 8.0±8.8). Complete right bundle branch block (CRBBB) remained, and a transient complete AVB emerged after 8 mo in 1 case, IRBBB in 1 case, and CRBBB with left anterior hemiblock (LAH) in 1 case. The clinical data and the outcome of the cases are shown in Table 1.

Discussion

Complete AVBs occurred in approximately 1% of patients undergoing surgical repair of PMVSDs.[11] Some studies have reported the incidence of transient complete AVBs in up to 1%–5% of patients undergoing transcatheter device closure of a PMVSD.[6,12] In our study, the incidence of AVBs was 3.5%. The exact underlying mechanism of an AVB remains speculative, but the occurrence of an AVB in the procedure when the arteriovenous loop was created or the occluder deployed in the septum, suggests the system of conduction was injurious. By definition, a part of the margin of the PMVSD is the area of fibrous continuity between the atrioventricular valves that forms the posteroinferior border. It is in this area that the aterioventricular conduction bundle emerges from the central fibrous body to become subendocardial, and may be prone to damage from a catheter or a PMVSD occlusion device.[13] The mechanism of an AVB during and after the procedure may be different. An AVB occurring immediately during the procedure may result directly from mechanical injury by catheter or devices. An AVB occurring after the procedure may be due to local inflammation and fibrosis.[7] The left and right ventricular retention disks may result in a localized area of edema and inflammation, which affect the proximal conduction system. Bundle branch block persisted among patients who developed complete AVBs after the procedure, indicating that the local inflammation mechanism contributed to the arrhythmia. Walsh et al. believed that device flattening was another mechanism that may be responsible for some of the delayed occurrences of AVBs,[7] but the shape and the size of the devices did not change significantly in his study. Butera reported delayed onset of complete AVBs after percutaneous closure of the PMVSDs,[14] and transient complete AVBs also occurred after 8 mo in 1 case in our report, but the mechanism of the arrhythmias is still unknown.

It is a difficult issue to know how to avoid AVBs. We felt that the procedure would have to be abandoned if an AVB occurred while crossing the defect with the catheter, delivery sheath, or device. In our report, AVBs disappeared quickly after discontinuing the procedure in 2 patients who developed an AVB during the procedure. Device selection may be an important factor for AVBs. Using a suitable size occluder may reduce the rate of AVBs.[7] Walsh suggested that it is more suitable to choose a device that is 0.5–1 mm larger than the diameter of the PMVSD, as measured on a TEE.[7] However, the current Amplatzer PMVSD occlusion device available is only in increments of 2 mm.

High-dosage steroid and aspirin, both very powerful anti-inflammatory agents, may be useful in reversing AVBs,[6,15] but the effectiveness of these drugs has yet to be determined. In the surgical literature,[16] patients

Published online in Wiley InterScience. (www.interscience.wiley.com)
DOI:10.1002/clc.20243

TABLE 1: The clinical data and outcome of the cases

Case	Sex	Age (y)	Diameter of VSD (mm)	Diameter of occluder (mm)	Procedure time (min)	AVB types	Occurred time	Recover time	Turnover
Case 1	Female	3	3.8	–	45	Mobitz type II	In procedure	3 min	Normal
Case 2	Male	18	8.0	10	70	CAVB	In procedure	8 min	Normal
Case 3	Female	6	6.0	8	110	CAVB	64 h after procedure	6 d	CRBBB, LAH
Case 4	Female	17	6.0	8	90	CAVB	23 h after procedure	3 d	CRBBB
Case 5	Female	34	4.0	6	100	CAVB	76 h after procedure	21 d	ICRBBB
Case 6	Male	8	12.0	14	80	CAVB	52 h after procedure	2 d	Normal

Abbreviations: AVB = atrioventricular block; CAVB = complete atrioventricular block; CRBBB = complete right bundle branch block; ICRBBB = incomplete right bundle branch block; LAH = left anterior hemiblock; VSD = ventricular septal defect.

with transient complete heart block and postoperative recovery were at higher risk for later-life heart blocks than those who had sinus rhythm throughout their operative course. This may also be true for transcatheter closure of a PMVSD. In our study, a transient complete AVB emerged again in 1 patient 8 mo after the complete AVB disappeared. In the report of Breur et al.,[15] a paroxysmal complete AVB with pathological pauses occurred 4 mo after transcatheter closure a PMVSD in 1 patient who underwent a transient complete left bundle branch AVB when the device was released, and an IRBBB after the procedure. Therefore, close attention should be paid to the patients who underwent heart block during or after the procedure.

Implantation of permanent pacemaker or not, and the time of implantation for patients who developed complete AVBs after transcatheter closure of a PMVSD, needs a large sample study. In the report of Walsh,[7] the permanent pacemakers were no longer being activated in all 3 patients who developed AVBs after the procedure, because their AVBs had disappeared. In the study of Yip,[6] complete heart block also disappeared in both cases after high-dosage steroid and aspirin were administered. In our study, atrioventricular conduction recovered after 21 d in 1 patient who refused to accept a permanent pacemaker. The time point of a permanent pacemaker implantation needs large sample studies in the future and it would be prudent to implant a permanent pacemaker.

In brief, an AVB is a major complication during and after transcatheter closure of a PMVSD. There is much uncertainty surrounding the incidence, natural history, and the treatment of AVBs. More attention needs to be paid to the complication and larger sample studies are needed in the future.

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Published online in Wiley InterScience. (www.interscience.wiley.com)
DOI:10.1002/clc.20243

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Published online in Wiley InterScience. (www.interscience.wiley.com)
DOI:10.1002/clc.20243