

## Rhythm and conduction abnormalities after transcatheter closure of VSDs: A single-center experience

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In this report, we describe our experience focusing on the acute and mid-term conduction disturbances and arrhythmias after transcatheter VSD closure and review the patients therapy and follow-up.

The medical records of 45 patients undergoing transcatheter VSD closure were retrospectively assessed in the Pediatric Cardiology Department from August 2007 to 2012.

The VSD diameters were measured by transthoracic (TTE) and/or transesophageal echocardiography (TEE) color on the right side of the septum for all defects.

The patients were hospitalized three days after the procedure. All subjects underwent a physical examination, ECG, chest radiography, 24-hour ECG-Holter monitoring, and TTE before discharge and at one, three, six, and 12 months after the procedure and yearly thereafter. All ECG and 24-hour Holter monitoring records were analyzed for conduction disturbances and arrhythmias.

At the time of device implantation, the patients ranged in age from 15 months to 58 years old (mean: 10.8 years). Mean body weight was 30.2 kg (range: 8.7-78 kg). The VSD diameters were between 3.5 and 8.5 mm according to echocardiography (mean: 5.6 mm).

All defects were occluded with Amplatzer devices (AGA Medical Corp., Golden Valley, MN, USA). Amplatzer [perimembranous VSD (pmVSD) occluders (PMVSDO)] were used for 14 patients (mean size of devices: 6.4 mm, range: 4-9 mm), muscular VSD occluders (MVSDO) for 26 patients (mean size: 6.9 mm, range: 4-10 mm), and duct occluders (ADO) for five patients (three of them 6/4, two of them 8/6). Muscular VSD occluders were used for 14 patients with pmVSD, having an aortic rim greater than 4 mm and muscular extension. In the first month following the procedure, small residual defect and mild tricuspid insufficiency was observed in one patient (2.2%), and moderate

tricuspid insufficiency without residue was seen in another patient. The mean duration of the follow-up period was  $25.7 \pm 14.2$  months (median: 26 months, range: 1-49 months).

Early complete atrio-ventricular blocks (cAVBs) developed in two (6.9%) of 29 patients with closed pmVSDs in (cases 1 and 2) (Fig. 1). Insignificant rhythm disturbances were seen in 24.4% (11/45) of the patients. Clinical characteristics, defect locations, device types, and ECG characteristics of patients who suffered from disorders of rhythm and conduction are shown in Table 1.

Conduction defects which developed after transcatheter closure can be temporary or permanent (1, 2). The rate of major complications found in 12 separate studies, including a total of 820 patients in the literature, varies between 0-15%; the highest rate (0-8%) is related to cAVBs requiring pacemaker implantation (1, 3, 4). cAVBs can occur during the procedure, but there are also cases in which such blocks take as long as 39 months to emerge (2, 4-8). Predescu et al. (7) reported 22% (4/20) of patients had cAVBs late in follow-up. Based on these data, PMVSDO implantation was terminated at the researchers' institution and the majority of centers. In our study, although a high rate of conduction disturbances was observed, most of them were minor abnormalities such as RBBBs, LBBBs, and intermittent nodal rhythm. Only two were major (e.g., cAVB developed soon after VSD closure). The incidence of cAVBs was higher in percutaneous closure than surgery closure in our study, but patients recovered and returned to normal sinus rhythm after high-dose steroid and anti-inflammatory therapy. All patients had normal sinus rhythm at the follow-up period.

When a cAVB occurs during the first week after the procedure, according to the bibliography, the major part of such blocks resolves after steroid therapy (but some of the patients need

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**Table 1. Clinical characteristics, defect location, device types, and ECG characteristics of patients who suffered from disorders of rhythm and conduction**

Case Number	Age, year	Weight, Kg	Defect localization	Defect size, mm	Device	Device size, mm	ECG changes	Time of ECG changes	Therapy, therapy period	Follow-up period	Results
1	6.5	20	PM	5.5	PMVSDO	6	cAVB	6 days	Temporary pacemaker+Steroid (3 weeks) + Aspirin (4 weeks)	24 months	RBBB
2	8	24	PM	6	MVSDO	6	cAVB + AV dissociation	During the procedure	Steroid (5 days)	5 months	Normal
3	15	50	PM	8	MVSDO	8	Nodal rhythm	2 days	Steroid+aspirin (5 days)	1 months	Normal
4	7	27.5	PM	4.5	PMVSDO	5	Second-degree type II AV block + bundle branch block at increased heart rate	29 months		44 months	Incomplete RBBB
5	6.5	18	PM	7	PMVSDO	9	LBBB+SVT with wide QRS	1 and 24 months	Metoprolol suksinat	40 days	Normal
6	8	28	PM	4.5	PMVSDO	6	Nodal rhythm + RBBB+SVE	2 days	Steroid	4 months	Normal
7	7.5	19	PM	7	PMVSDO	7	LBBB + second-degree type II AV block	5 days and 30 months		36 months	Rare second-degree type II AV block
8	12	32.6	PM	4	ADO	6/4	LBBB + Lown grade 1 VE	4 days	Steroid (5 days)	2 months	Normal
9	32	65	PM	6	PMVSDO	8	LBBB	2 days		42 months	Normal
10	7.5	18.5	PM	6	MVSDO	6	Lown grade 1 VE	1 month		38 months	Lown grade 1 VE
11	2.5	8.8	Muscular	7	MVSDO	10	Lown grade 2 VE	1 month		31 months	Normal
12	4.4	14.8	Muscular	10/5.5	MVSDO	8	Lown grade 1 VE	6 months		24 months	Normal
13	13	52	Muscular	7	MVSDO	9	Frequent SVE, Lown grade 1 VE	10 days		6 months	Normal

ADO - amplatzer duct occluder; AV - atrioventricular; cAVB - complete atrioventricular block; LBBB - left bundle branch block; MVSDO - muscular ventricular septal occluder; PM - perimembranous; PMVSDO - perimembranous ventricular septal occluder; RBBB - right bundle branch block; SVE - supraventricular extrasystole; VE - ventricular extrasystole

pacemakers). Late cAVBs are those occurring > seven days after the procedure; this kind of block is typically permanent and always requires a pacemaker. This kind is worse, and fortunately was not found in our study.

Bundle branch blocks are common after percutaneous VSD closure and considered minor conduction disturbances. However, they are important since they progress to second-degree AVBs (6, 8-10). In our study, second-degree II AVBs developed in two patients with bundle branch blocks (patients 4 and 7) in the follow-up period. Even if the bundle branch blocks disappear, such patients should be closely monitored for the advanced AV block.

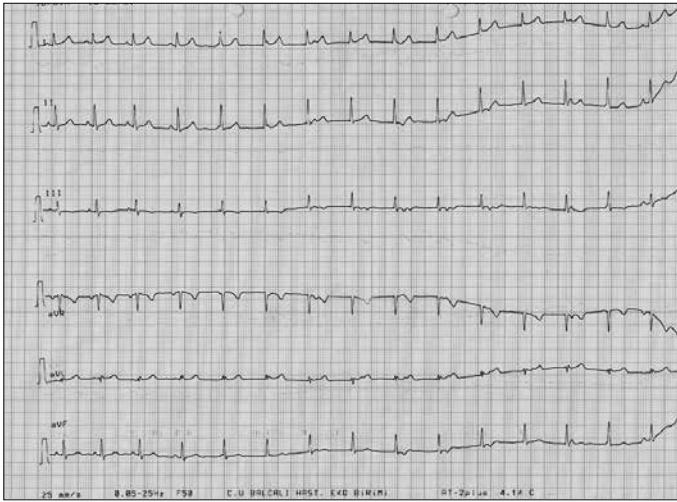
In the follow-up period, isolated VE was seen in three patients and, VE and SVE in one patient. Isolated VE was reported after the percutaneous closure of a muscular VSD, but it is difficult to say that VE occurred as result of the closure procedure. It is necessary to perform Holter monitorization before the

procedure to distinguish whether such minor arrhythmias are accidental or occur as a result of the procedure.

Close monitoring of patients' rhythm is important after VSD closures. Conduction and rhythm disorders can either develop during the procedure or occur months later. However, it is not always possible to say that especially late-onset rhythm disorders originate from the procedure. To make this distinction, we performed Holter monitorization on our patients before the procedure.

## Conclusion

The incidence of AVBs after percutaneous pmVSD closure is relatively high, but the outcome of early developed AVBs after transcatheter VSD closure was satisfactory in our study, as most of them were temporary. Intensive anti-inflammatory therapy is important in the treatment and prognosis of early devel-



**Figure 1. ECG the next day in case 2 demonstrating an AV dissociation**

oped AVBs, that the patients should be closely monitored for the first week after the procedure. Twenty-four-hour Holter monitoring should be performed before the procedure to determine whether minor abnormalities are related to the procedure.

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