Complete atrioventricular block after percutaneous device closure of perimembranous ventricular septal defect: A single-center experience on 1046 cases

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BACKGROUND Complete atrioventricular block (cAVB) has been deemed a rare complication after transcatheter closure for ventricular septal defect (VSD). However, this serious event appears to be underrecognized and is worth being investigated further.

OBJECTIVES To determine the incidence and predisposing factors of cAVB associated with closure of VSD using a modified double-disk occluder (MDO).

METHODS From December 21, 2001 to December 31, 2014, 1046 patients with perimembranous ventricular septal defect underwent percutaneous closure using the MDO. Electrocardiography was evaluated before the procedure, within 1 week after the procedure, and then at 1, 3, 6, and 12 months and every year thereafter. Other baseline and procedural parameters were also evaluated and a comparison between patients requiring pacemakers and those not suffering from cAVB was done.

RESULTS cAVB occurred in 17 patients (1.63%) after the procedure. Of the 17 patients, 8 (0.8%) underwent permanent pacemaker (PPM) implantation. The cAVB occurred within 30 days after the procedure in 14 patients and after 1 year in 3 patients. In comparison patients aged $\leq$18 years, patients aged $>$18 years were more prone to cAVB ($P = .025$). Logistic regression revealed no significant parameter to predict later requirement for PPM.

CONCLUSIONS The incidence of cAVB after transcatheter closure of VSD was acceptable, as part of the cAVB population recovered after administration of corticosteroid and application of a temporary pacemaker. Late cAVB ($>$1 year) appears to make it more difficult to restore normal conduction block. Because of the recurrence of cAVB, life-long follow-up with periodic electrocardiography examination may be mandatory.

KEYWORDS Complete atrioventricular block; Perimembranous ventricular septal defect; Complication; Percutaneous

ABBREVIATIONS **AV** = atrioventricular; **cAVB** = complete atrioventricular block; **CRBBB** = complete right bundle branch block; **ECG** = electrocardiography; **MDO** = modified double-disk occluder; **pmVSD** = perimembranous ventricular septal defect; **PPM** = permanent pacemaker; **TTE** = transthoracic echocardiography; **VSD** = ventricular septal defect

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Introduction

Percutaneous device closure of perimembranous ventricular septal defect (pmVSD) has been widely accepted and also associated with excellent rates of closure.[1–3] Avoiding sternotomy and cardiopulmonary bypass, the transcatheter approach is assumed to reduce perioperative morbidity and mortality as compared to conventional surgical repair. Nevertheless, the transcatheter technique has subsequent complications, such as embolization of the occluder, valve impairment, and arrhythmia. Complete atrioventricular block (cAVB) is a rare but serious complication of the procedure.[4–6] Previous literature has described that cAVB can occur immediately or later after transcatheter occluder closure.[7–9] Since the exact mechanism of postoperative cAVB is not fully investigated, the occurrence of cAVB in patients treated with percutaneous interventions is unpredictable. Additionally, there is a lack of studies describing incidence of cAVB and predictors of pacemaker requirement following ventricular septal defect (VSD) closure. Therefore, the aim of this study was to determine the evolution of cAVB and predisposing factors of pacemaker implantation associated with VSD closure using a modified double-disk occluder (MDO) in a single institution.

Methods

Study population

From December 21, 2001 to December 31, 2014, 1046 patients with pmVSD underwent percutaneous closure

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using an MDO in Changhai Hospital, Shanghai. The patients or, if minors, patients' parents gave their written informed consent to the procedure. The local Ethics Committee approved this protocol. This study complied with the Declaration of Helsinki. The criteria for inclusion in this study included: (1) age $\geq$1 year; (2) body weight $\geq$12 kg; (3) maximum diameter of VSD $\leq$16 mm by transthoracic echocardiography (TTE); (4) defect located at 9 to 12 o' clock positions in the short axis parasternal view of TTE (Figure 1); (5) a significant left-to-right shunt across the defect; (6) a distance of $\geq$1 mm from the VSD to the aortic valve; and (7) mean pulmonary artery pressure $\leq$70 mm Hg evaluated by catheter. Exclusion criteria included patients with endocarditis, NYHA class III and IV, severe pulmonary hypertension ($>$70 mm Hg), sepsis, and contraindications to antiplatelet therapy.

Description of modified double-disk occluder

The MDO is a self-expandable double-disk device made from a Nitinol wire mesh (ShangHai Shape Memory Alloy Co Ltd, Shanghai, China). There are a total of 3–5 polyester patches in each disk. The polyester patches filled in the disks can guarantee the sealing of the occluder. There were 3 subtypes of MDO: symmetric occluder, asymmetric occluder, and thin-waist occluder. In the symmetric occluder, the left disk is symmetric. The diameter of the disk is 4 mm larger than that of the waist. In an asymmetric occluder, the flange of the left ventricular disk, which faces the aortic valve, is 0 mm larger than the waist, while the flange of the disk that is on the opposite side of the aortic valve is 6 mm larger than the waist. The diameter of the left ventricular disk of the thin-waist occluder was 8 mm larger than that of the waist. The right ventricular disc of the asymmetric and thin-waist

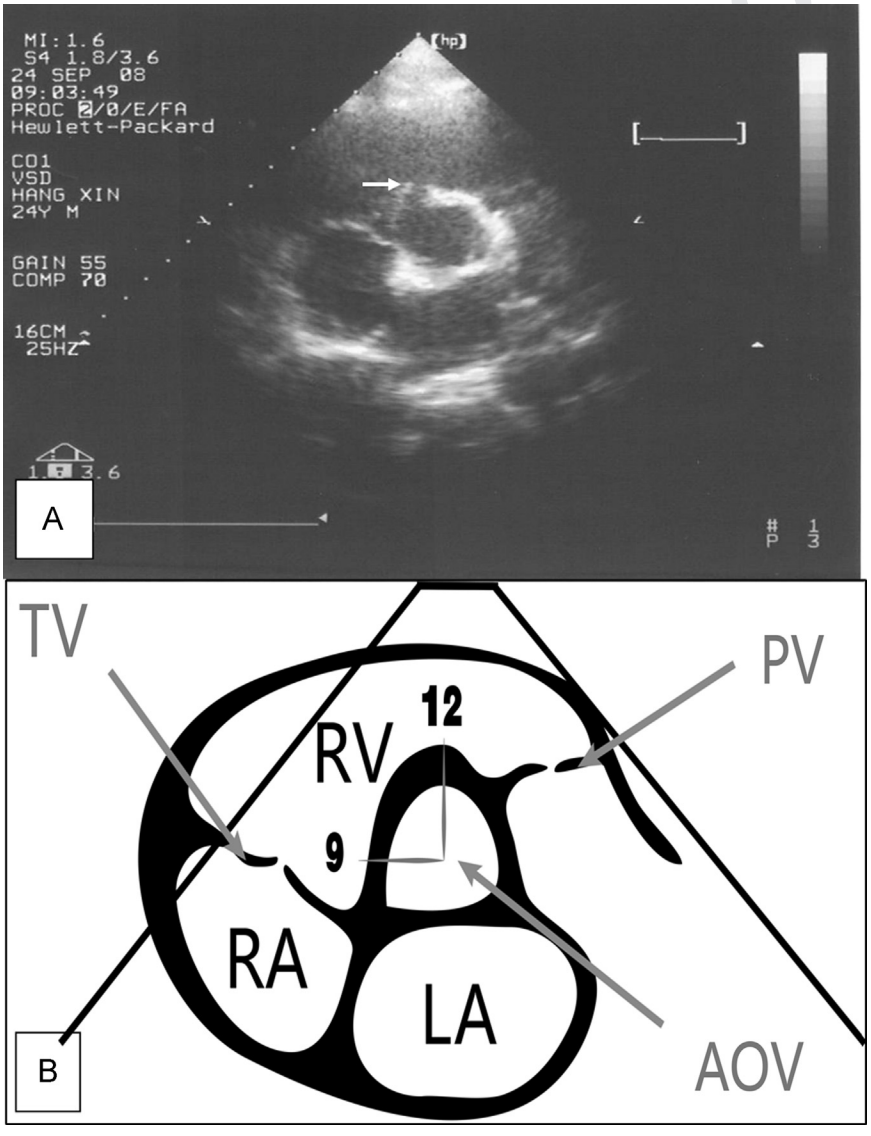

Figure 1 Graphic examples of the criteria for study inclusion. **A:** Transthoracic echocardiography image (short axis parasternal view) confirms the location of the defect (*arrow*) to the perimembranous area. **B:** Schematic diagram of the location of ventricular septal defect (the defect located at 9 to 12 o'clock positions in the short axis parasternal view).