Transfemoral and Perventricular Device Occlusions and Surgical Repair for Doubly Committed Subarterial Ventricular Septal Defects

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Background. **Transfemoral and perventricular device occlusions are performed for doubly committed subarterial ventricular septal defect (dcVSD) to reduce the invasiveness of the conventional surgical repair through a median sternotomy. Few comparative studies have been conducted of these three procedures.**

Methods. **Inpatients with isolated dcVSD who had undergone transfemoral and perventricular device occlusions or conventional surgical repair from January 2009 to June 2013 were reviewed to compare the three procedures.**

Results. **Procedure success was achieved in 33 transfemoral (66%), in 74 perventricular (94.9%), and in 205 repair (97.6%) procedures. The transfemoral group had the lowest success rate ($p < 0.001$), whereas the perventricular and repair groups had similar success rates ($p = 0.418$). Transfemoral patients were the oldest ($p < 0.001$) and had a dcVSD size similar to that of patients in other two groups ($p = 0.518$). The repair group required the longest hospitalization and longest stays in the intensive care unit ($p < 0.001$), required the longest operating room and mechanical ventilation times ($p < 0.001$), and had the highest rate of transfusion ($p < 0.001$). Major adverse events occurred in one transfemoral (3%), in two perventricular (2.7%), and in three repair (1.4%) procedures. Minor adverse events were absent in transfemoral (0%) and occurred in three perventricular (4%) and 14 repair (6.7%) procedures. No significant difference was noted in the rates of adverse events the three groups ($p = 0.569$). No grade 3 valvular regurgitation or complete atrioventricular block was observed in the studied patients.**

Conclusions. **Device occlusion may be an alternative to surgical repair in selected patients with dcVSD. Perventricular occlusion was the preferred approach because it showed a higher success rate than transfemoral occlusion.**

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Ventricular septal defect (VSD) is one of the most common congenital cardiac defects [1]. Doubly committed subarterial ventricular septal defect (dcVSD), also referred to as supracristal, subpulmonary, or infundibular VSD, is a unique type of VSD with a high incidence in Asian populations, accounting for as many as one quarter of defects requiring surgical closure [2]. Because of the lack of muscular support and the Venturi pulling effect on the leaflet, the aortic valve tends to prolapse into the defect, resulting in aortic insufficiency [3, 4]. Whereas spontaneous closure of other types of VSD is estimated to be between 25% and 50% in patients followed up from birth, spontaneous closure of dcVSD is extremely rare. Early closure is recommended for this type of VSD [5, 6].

Transfemoral occlusion using the Amplatzer ventricular septal defect occluder was first described in 2002 by Hijazi and colleagues [7]. Since then, many reports have been published regarding the transfemoral device closure of perimembranous VSD and muscular VSD [8–10]. Although it is technically difficult, transfemoral device closure for dcVSD has also been tried in a few centers [11, 12]. Recent years have also witnessed the development of perventricular device closure, which has soon been applied to dcVSD [13–15].

Conventional surgical repair through a median sternotomy is considered gold standard for dcVSD closure. The clinical outcomes of new treatment modalities should be compared with that of the gold standard. As indicated by our literature review, few comparative studies have been conducted among transfemoral occlusion, perventricular occlusion, and conventional surgical repair. Therefore, in the present study, we compared the outcomes of these three procedures in dcVSD.

Material and Methods

We reviewed the records of patients who underwent transfemoral occlusion, perventricular occlusion, and

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conventional surgical repair for dcVSD at Union Hospital, Fujian Medical University, and Zhongshan Hospital, Fudan University, between January 2009 and June 2013. Patients with the following conditions were excluded: significant cardiac and noncardiac comorbidities that could affect the clinical outcome of defect closure, evidence of significant heart failure at admission, VSD with right-to-left shunting caused by severe pulmonary hypertension, maximum diameter of the defect above 10 mm as shown by transthoracic echocardiography, and age younger than 3 months. A dcVSD with a subpulmonary rim of 2 mm or less was excluded from attempted transfemoral occlusion. The residual shunt was classified as small if the width was 2 mm or less and as large if it was more than 2 mm. Patients were considered to have successful VSD closure if they had no large residual shunt as assessed by postoperative echocardiography. Informed consent was obtained from each patient or the legal guardian before any of the procedures.

VSD Occluder

The VSD occluder is a self-expandable, double-disk device (Shanghai Shape Memory Alloy Co, Ltd., Shanghai, China). Asymmetric occluders were used in our study. The diameter of the left disk is 6 mm larger than that of the waist. The left disk extends toward the apex, and no superior margin extends toward the aorta. The left disk has a platinum marker that is used to guide device orientation. The right ventricular disk is 2 mm larger than the waist. The occluder is sized according to the waist diameter, which ranges from 4 mm to 18 mm.

Transfemoral Device Occlusion

The transfemoral occlusion was performed with the patient under general anesthesia or under sedation and local anesthesia. The technique has been previously described [11, 12]. Before the occluder was released, transthoracic echocardiography was conducted to check for possible adverse events. If no severe adverse event was recorded, the device was released. Antibiotic prophylaxis was administered half an hour before the procedure in all patients. After the procedure, those who had received general anesthesia were extubated in the catheter laboratory. The vascular sheath was immediately removed in all patients, and hemostasis was achieved at the access site by manual compression. After the procedure, all patients were transferred to the general ward and were given dexamethasone for 2 to 3 days. Continuous electrocardiographic (ECG) monitoring was performed during the first 24 to 48 hours, as were routine urinalysis and 12-lead ECG. Before discharge, transthoracic echocardiography was conducted. All patients received routine maintenance therapy with aspirin 3 to 5 mg/kg daily or equivalent antiplatelet therapy for 6 months. Follow-up assessments were carried out at the approximate time points of the 1st, 3rd, and 12th months in the first year and once yearly thereafter (Fig 1).

Perventricular Device Closure

Intraoperative transesophageal echocardiography (TEE) was used to guide the procedure. An inferior median sternotomy was made (about 3 to 5 cm). The pericardium was opened and suspended to expose the right ventricle. A pursestring suture was placed at the puncture site, and an angiocatheter was introduced into the right ventricular cavity within the pursestring. A guidewire was passed through the catheter and into the right ventricular cavity. A short introducer sheath was fed over the wire and manipulated into the left ventricular cavity through the VSD under TEE guidance. The device was advanced inside the delivery sheath, and the left ventricular disk was deployed first. The platinum marker on the left disk was kept toward the apex, and the right ventricular disk was deployed by withdrawing the sheath. If the result according to TEE was satisfactory, the device was released. Routine chest closure with placement of a drainage tube was performed. Prophylactic antibiotics were administered in the operating room and continued until the tube was removed. Dexamethasone was given for 2 to 3 days. The patients were transported to the intensive care unit (ICU), where continuous ECG was routinely used. Routine urinalysis and 12-lead ECG were performed after the patients were transferred to the general ward, and transthoracic echocardiography was performed before discharge. Patients received routine maintenance therapy with aspirin 3 to 5 mg/kg daily or equivalent antiplatelet

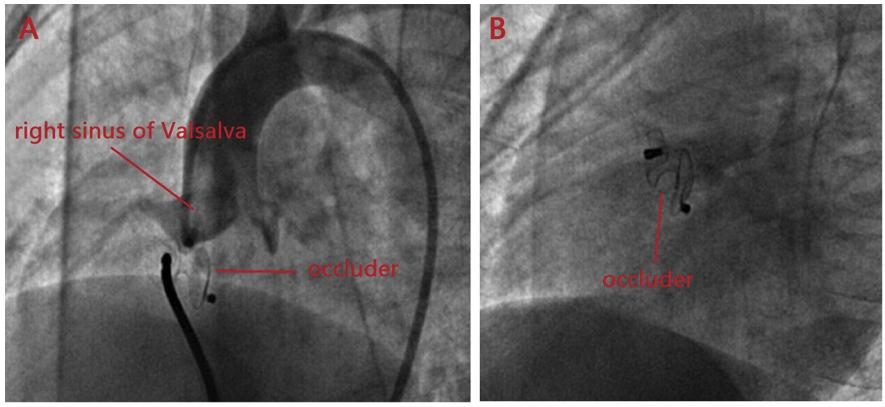

Fig 1. Transfemoral occlusion of dcVSD. (A) Aortic angiographic view showing that the occluder was just under the right sinus of Valsalva. (B) Perpendicular view of the occluder after deployment.