



TRANSCATHETER CLOSURE OF PERIMEMBRANOUS VENTRICULAR SEPTAL DEFECT USING SINGLE ARTERIAL ACCESS

Yusubov Alisher¹

Inagamov Surat²

Ko Hoon³

¹Department of Pediatric Cardiology and angiography, National Children's Medical Center, Tashkent, Uzbekistan.

²Department of Pediatric Cardiac Surgery, National Children's Medical Center, Tashkent, Uzbekistan.

³Department of Pediatrics, Research Institute for Convergence of Biomedical Science and Technology, Pusan National University Yangsan Hospital, School of Medicine, Pusan National University, Yangsan, Republic of Korea.

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ABSTRACT

OBJECTIVES: We adopted perimembranous (PM) ventricular septal defect (VSD) closure by using only femoral arterial access and choosing device size based on transthoracic echocardiography (TTE) without injection of contrast. Here, we have evaluated mid term results.

METHODS: From December 2022 to December 2023, patients with PM VSD, who treated percutaneously were retrospectively analyzed. Patients age, body weight, procedure time, VSD size, used occluder size, complications were analyzed. The day after the procedure and one month later, routine electrocardiography (ECG) and TTE were performed to find or exclude any type of device-related arrhythmias, residual shunt, new onset AR, or TR.

RESULTS: Among 56 patients, 28 were female, and the age median and range were 64 (14-180) months, Body weight 17,35 (8-70)kg. VSD sizewere 4,8 (3,2-7,8) mm. Procedure time were 40 (20-135) minutes. 13 patients had residual shunts less than 3mm, mainly due to the absence of fabric inside small devices, but one month later, it decreased to 8 patients. Nor new onset aortic regurgitation (AR) nither atrio-ventricular (AV) block observed. New mild TR occurred in 3 cases, likely due to tricuspid valve chordae entrapment and 1 patient had moderate TR. Device embolization occurred in one case. The device was successfully retrieved by snare, and a 2mm larger device was implanted.



INTRODUCTION

After the first successful closure of congenital ventricular septal defect (VSD) in 1987, there were many types of devices suggested and used in this field [1,2,3,4]. In 2002, Hijazi antegradely implanted Amplatzer membranous VSD occluder in 6 patients [5], and Kozlik-Feldmann R. reported results of coil implantation in 85 patients [6]. Initially, the antegrade approach was used for VSD closure, with an arteriovenous (AV) loop established. With the improvement of device characteristics, it became possible to deliver and implant the device by retrograde approach [7,8]. Ece I. showed how to perform VSD closure only by venous access with an antegrade approach [9]. All these procedures took 46-120 minutes [2,10,11,14]. According to different sources, complications vary within new aortic regurgitation (AR) up to 5% even ten years later, tricuspid regurgitation (TR) up to 20%, complete atrioventricular block (CAVB) up to 2.8%, device embolization up to 8.8%, residual shunt up to 26% [3,5,9,11,12,13,14,18]. Moreover, there are case reports of device-related hemolysis, vegetation, and perforation of the right aortic cusp [6,15,16]. A relatively new Lifetech MFO occluder was implanted only retrogradely, and the mean procedure time was 57 minutes [8]. Koneti NR. Reported only arterial access usage with Amplatzer ADO II, while Sadiq M. reported VSD closure by puncturing both femoral arteries [17,20]. Jiang D. reported retrograde VSD closure by using a puncturing of the femoral artery and vein [19].

The aim of this study is to describe modified transcatheter closure of perimembranous (PM) VSD using an antegrade approach and only arterial access, which is performed without left ventricle (LV) angiography.

MATERIALS AND METHODS

Study population

From December 2022 to December 2023, 153 patients with VSD treated percutaneously at National Children's Medical Center. During review of records, we left only PM VSD which were closed retrogradely and excluded muscular VSD and PM VSD in which used antegrade approach. Retrospective analyze performed in 56 patients.

Among them, 28 were female, and the age range was 14-180 months, with a median of 67 months. Body weight range and median were 8-70kg and 17,35kg, respectively. Diagnosis was made by transthoracic echocardiography (TTE), and all patients had hemodynamically significant PM VSD. Median defect size and range were 4,8 mm, 3,2-7,8 mm, respectively.

Echocardiographic protocols and definition

TTE performed on GE Vivid IQ with 6S-RS 2,7-8,0MHz and 3Sc-RS 1,7-4,0MHz probes (General Electric Corporation, Norfolk, Virginia). All patients underwent TTE exams before, during the procedure, the next day of the procedure, and 1 month later. Defect size, distance to the aortic valve (AV), and pressure gradient measurement were performed.

Device implantation technique

All procedures are performed under general anesthesia and done by the same interventional cardiologist. One dose of antibiotics was received before the procedure and continued for the next three days. The size of the implanting device selected was 0,5-1mm larger than measured by TTE. After puncture of the femoral artery and insertion of 5F sheath, intravenous Heparin (100 IU/kg) infusion was initiated. 5F Judkins right (JR) coronary catheter and Terumo GR3516 Hydrophilic Coated Guidewire (GW) 0,035"-260cm inserted up to the



aortic arch. Then only GW descended to a right coronary cusp (RCC) of AV until creating a bend, angulation of the angiography tube changed from posterior-anterior to 40° left anterior oblique (LAO) / 20° cranial view and stored by making scintigraphy (Figure 1). This picture serves as a guide during crossing VSD and implantation of occluder. After knowing the level of AV, the GW was inserted into LV and tried to cross VSD. In case of difficulty crossing VSD, JR or a cut pigtail catheter is used to do it. After entering the right ventricle (RV), GW drifted to the branch pulmonary artery (PA). Then, the catheter and sheath were changed to the delivery system of Lifetech Konar MFO as recommended by device size. The tip of the delivery system is put at the apex of the RV. During the deployment of the device, the RV disc was deployed, and the whole system was pulled back until the shape of the device changed and the LV disc was deployed. The mandatory point is making ascending aortography to exclude AV cusp entrapment (Figure 2). Contrast is used only to check AV intactness. Finally, the existence or absence of AR, TR, residual shunt, or any type of arrhythmia was checked, and the device was released.

Follow-up protocol

The day after the procedure and one month later, routine electrocardiography (ECG) and TTE were performed to find or exclude any type of device-related arrhythmias, residual shunt, new onset AR, or TR.

Statistical analysis

SPSS 23.0 version was used for the purpose of data analysis. Continuous variables are demonstrated as medians and ranges.

RESULTS

In all cases, the procedure was completed successfully. Median procedure time was 40 minutes, and the range was 20-135 minutes. 13 patients had residual shunts less than 3mm, mainly due to the absence of fabric inside small devices, but one month later, it decreased to 8 patients and did not cause pulmonary blood overload.

We did not find any new onset AR, even in cases where the device was located too close to the AV.

New mild TR occurred in 3 cases, likely due to tricuspid valve chordae entrapment and 1 patient had moderate TR. In a one-month follow-up, there were no patient with AV block, all other data given in table 1.

During the procedure, in one case, device dislocation and embolization to the right pulmonary artery occurred. The device was successfully retrieved by snare, and a 2mm larger device was implanted.

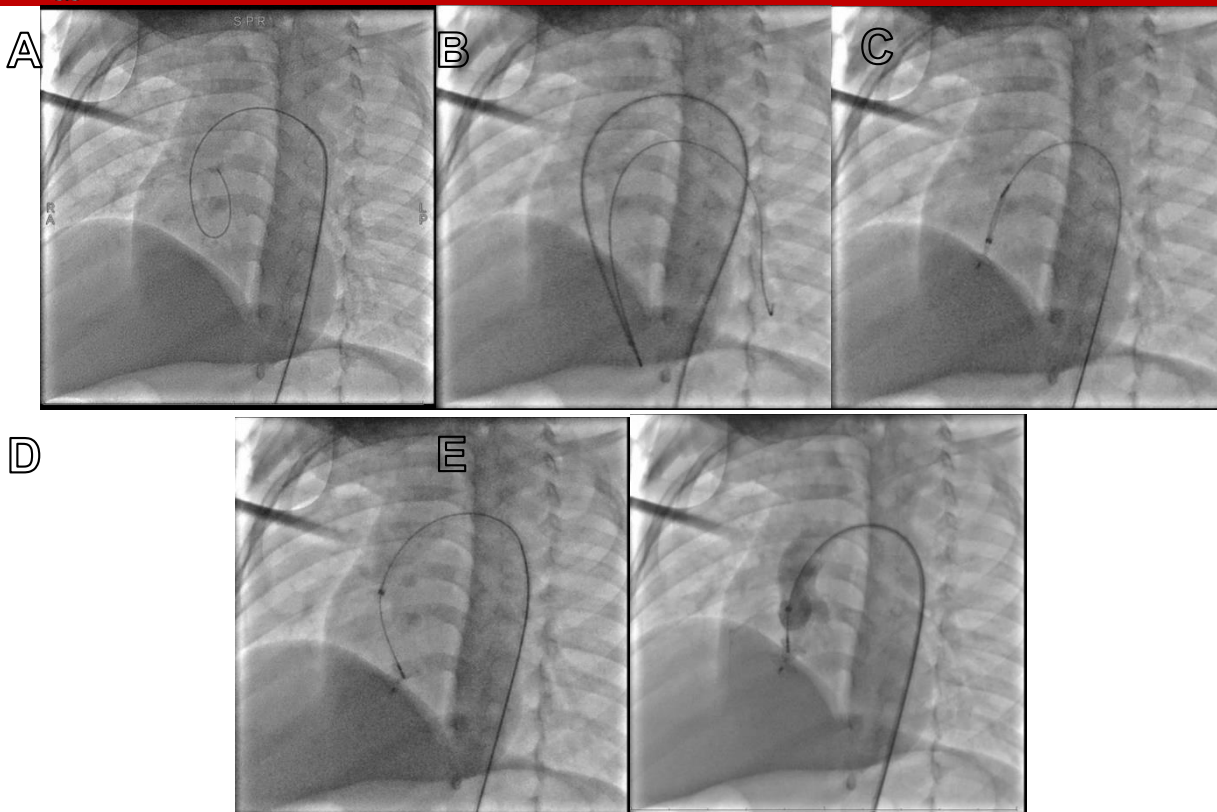


Figure 1. Process of VSD occludes implantation. **A:** 0.035"-260 Terumo GR3516 Glidewire® Hydrophilic Coated GW bend on the AV, which shows the level of the AV. **B:** Over the GW, insert the delivery system, and the tip of the system is pointed at the apex of the RV. **C:** RV disc unsheathed and deployed. **D:** LV disc unsheathed and deployed. **E:** An ascending aortography is needed to confirm the intact aortic valve.

VSD – ventricular septal defect. GW-guidewire. AV-aortic valve. RV-right ventricle. LV-left ventricle.

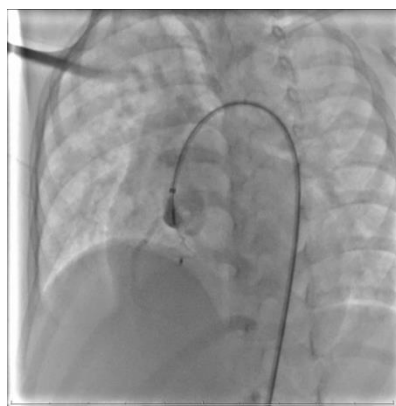


Figure 2. LV disc of the device captured the right coronary cusp of AV. LV-left ventricle. AV-aortic valve

Table I. Echocardiographic characteristics, procedural data, complications.

Variable	Result
VSD median size (ranges) in mm	4,8 (3,2-7,8)
Used device median size (ranges) in mm	7x5 (5x3 – 10x8)



Procedure time, median (ranges) in min	40 (20-135)
Complications	
-AR	0
-TR	7%
-Residual shunt	14%
-AV block	0
-Device embolization	1,7%

DISCUSSION

Transcatheter PM VSD closure using only arterial access became feasible due to device advancement and profile reduction of the delivery system, even in a small child. The main advantage of this method was the shortage of time spent on the procedure. Closing the defect in a short time and, at the same time, avoiding complications in children is very important. By using this method, the procedure time was 40 (20-135) minutes because crossing the VSD is much easier and faster from the LV side. Moreover, a detailed examination of the VSD and the choice of device size based on echocardiography data allows one to avoid the injection of excess contrast. Contrast is used only to check AV involvement.

Previous studies showed average more than 49 minutes. Various authors performed using antegrade and retrograde approach, but in both ways used puncture femoral artery and vein together, and both femoral arteries together [10,20]. One author reported transcatheter closure VSD only with arterial access by using Amplatzer ADO II, but defect size was limited by 6,5mm, due to device limitations [20].

Transcatheter VSD closure using only arterial access with Lifetech Konar MFO device allows for reducing the cost of the procedure (less contrast, one sheath, no need in snare).

This method and device have disadvantages also. Common complications were residual shunt, 14%. One reason is small devices has not fabric inside and another is device is too soft. TR also can occur, in our cases 7%. There need to very careful to not catch tricuspid valve chordae.

There is a need for further comparison of this method of transcatheter VSD closure with other methods that are larger required. This method requires multicenter comparison with other defect closure approaches.

CONCLUSION

This method was safe and effective for the treatment of PM VSD. However, residual shunt through the device and TR may occur. Usually, this complication is tolerable. On the other hand, crossing the VSD is much easier and faster from the LV side.

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