Heart, Lung and Circulation (2016) xx, 1–6
1443-9506/04/$36.00
http://dx.doi.org/10.1016/j.hlc.2015.06.834

ORIGINAL ARTICLE

Transcatheter Closure of Perimembranous Ventricular Septal Defects Using Dual Wire-Maintaining Technique

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Received 15 April 2015; received in revised form 29 May 2015; accepted 6 June 2015; online published-ahead-of-print xxx

Objective The present study was designed to evaluate the safety and feasibility of transcatheter closure of perimembranous ventricular septal defects (PmVSDs) with dual wire-maintaining technique (DWMT).

Patients/Methods From January 2010 to December 2013, a total of 241 patients (men: 109, women: 132; mean age: 22.2 ± 15.4 years) with congenital PmVSDs were randomised to either the conventional technique (CT) group (n=118) or the DWMT group (n=123).

Results In the CT group, the track wire was withdrawn before occluder insertion. In the DWMT group, the track wire was maintained in the delivery sheath during the procedure. Both the procedure time and fluoroscope time were reduced significantly in the DWMT group patients who required device replacement compared with CT group patients (median time: 46.0 ± 14.8 min vs. 56.0±15.2 min, $P<0.05$; 15.0±11.6 min vs. 22.0 ±10.1 min, $P<0.05$). There was no difference in the incidence of complications between the two groups.

Conclusion The DWMT is safe and feasible for transcatheter treatment of PmVSDs, especially in patients requiring device replacement, for it avoids reconstruction of the ''arteriovenous wire loop'', left ventriculography from the contralateral femoral route, or the use of a larger femoral artery short sheath.

Keywords Transcatheter • Ventricular septal defect • Dual wire-maintaining technique

Introduction

Since the first report of transcatheter ventricular septal defect (VSD) closure using a double umbrella device in 1988[1], percutaneous closure has been offered as an alternative to surgery for perimembranous VSD (pmVSD) in many institutions. With the devolvement of interventional techniques and devices, the indications of transcatheter closure of VSDs have been widely extended. However, the initially selected occluder is not always appropriate due to the complexity of PmVSD and an ''arterial-venous wire loop'' has to be established repeatedly, which not only prolongs both the procedure time and fluoroscope time but increases the risk of complications. In the present report, we describe a dual

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Please cite this article in press as: Xu X-D, et al. Transcatheter Closure of Perimembranous Ventricular Septal Defects Using Dual Wire-Maintaining Technique. Heart, Lung and Circulation (2016), http://dx.doi.org/10.1016/j.hlc.2015.06.834

wire-maintaining technique (DWMT) that can not only avoid reconstructing the ''arterial-venous wire loop'' in patients requiring device replacement, but avoid puncturing the contralateral femoral or using a larger femoral artery short sheath, and evaluate the clinical feasibility and safety of a DWMT in comparison with the conventional technique for transcatheter closure of PmVSD.

Methods

Patients

Between January 2010 and December 2013, 340 patients with VSDs (perimembranous VSD, intracristal VSD, muscular VSD, postinfarction VSD and postoperative residual VSD) underwent transcatheter closure in our hospital. Inclusion criteria for VSD closure were (1) age ≥3 years; (2) maximum diameter of VSD ≤16 mm as diagnosed using transthoracic echocardiography (TTE); (3) defect location at 9 o'clock to 11 o'clock positions of an analog clock in the short-axis parasternal view; (4) the presence of a left-to-right shunt; and (5) pulmonary pressure ≤70 mm Hg as diagnosed using TTE. Patients with one of the following criteria were excluded: (1) age <3 years old; (2) moderate to severe aortic regurgitation; (3) right-to-left shunt; (4) postoperative residual defects; (5) left ventricle to right atrial shunts. Finally, a total of 241 patients fulfilling the above criteria were randomised to either the DWMT group (n=123) or the conventional technique (CT) group (n=118). The baseline characteristics of both groups are displayed in Table 1. Before intervention, an informed written consent was obtained from all patients or their guardians. The study was approved by the ethics committee of Changhai Hospital and was carried out in accordance with the Declaration of Helsinki (1996) and all relevant Chinese laws.

Table 1 Patients' characteristics at study entry (median with standard deviation).

	CT group	DWMT group
Patients (n)	118	123
Gender (female),n (%)	61 (51.7)	71 (57.7)
Age (years)	20.5±15.4	21.0±15.5
Weight (kilogram)	43.0±15.2	42.0±16.3
Age groups [n (%)]		
<10 years	33 (28.0)	37 (30.1)
10–20 years	26 (22.0)	24 (19.5)
>20 years	59 (50.0)	62 (50.4)
VSD size detected by TTE (mm)	4.0±1.5	5.0±1.8
Associated conditions		
Trivial to mild tricuspid regurgitation	40 (33.9)	41 (33.3)
Trivial to mild aortic regurgitation	4 (3.4)	5 (4.1)

CT, conventional technique; DWMT, dual wire-maintaining technique; VSD, ventricular septal defect; TTE, transthoracic echocardiography; TR, tricuspid regurgitation

The Occluders

The closure device used in this study was a modified double-disk occluder (Shanghai Shape Memory Alloy Ltd, China) corresponding to the Amplatzer occluder. There are three types of SHSMA perimembranous VSD occluder: symmetric, thin-waist symmetric and asymmetric occluder. All three types of occluders have a right circular disk, the diameter of which is 4 mm larger than that of the waist. The only difference between these occluders is the size and shape of the left disk. The left disk of the symmetric and thin-waist symmetric occluder is symmetric (circular). The diameter of the left disk is 4 mm larger than that of the waist in the symmetric occluder. In the thin-waist symmetric occluders, the diameter of the left disk is 8 or 12 mm larger (A_4B_2 or A_6B_2 occluder). In the asymmetric occluder, the diameter of the left disk is 6 mm larger than that of the waist, with the left disk extending toward the apex and no superior rim extending toward the aortic cusps.

Procedure of Transcatheter Closure

The procedure was performed under 1% lidocaine local anaesthesia for patients aged 10 years and above, while general anaesthesia with ketamine was used in younger children under the guidance of fluoroscopy and TTE. The right femoral vein (7 Fr short sheath) and artery (6 Fr short sheath) were accessed, and intravenous heparin (100 IU/kg) was administered. Pulmonary artery and right ventricular pressures and saturations were obtained. Shunt volume was calculated using oximetric measurements. The location, size, shape, and relationship of VSD with the surrounding tissue were assessed using TTE in all standard views before the procedure. Angiography in the left ventricle at a 45°/25° left anterior oblique projection/cranial was used to profile the VSD and the location and size of the VSD were assessed. The technique for VSD closure was performed as described previously [2,3]. After establishing a ''femoral arteriovenous wire loop'', an appropriate delivery sheath (6–12 Fr) was introduced over the track wire from the femoral vein and advanced across the VSD to the left ventricular apex. In the CT group, the track wire was withdrawn before the occluder was inserted into the sheath. After deployment of the occluder, left ventriculography and aortic root angiography were performed via the right femoral artery approach. If inappropriate, the occluder and delivery sheath were withdrawn and the ''arteriovenous wire loop'' was re-established to insert another occluder. In the DWMT group, the guidewire was maintained in the delivery sheath and the ''arteriovenous wire loop'' was maintained while inserting and deploying the VSD occluder. After deployment of the initial occluder, the short wire was inserted into the right femoral artery short sheath, which was withdrawn and re-inserted

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