Transthoracic Device Closure of Juxtaarterial Ventricular Septal Defects: Midterm Follow-Up Results

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Background. In recent years, minimally invasive transthoracic device closure has been introduced as an alternative treatment option for selected patients with juxtaarterial ventricular septal defects. This study evaluated the midterm safety and efficacy of using device closure in selected patients.

Methods. Between January 2008 and December 2014, 25 patients with juxtaarterial ventricular septal defects who met the inclusion criteria were enrolled in this study. Periventricular closure was attempted using minimally invasive transthoracic device closure without cardiopulmonary bypass under general anesthesia and transesophageal echocardiography guidance. Patients were strictly monitored according to a standard protocol by one specially appointed doctor.

Results. Minimally invasive transthoracic device closure was successfully performed in 23 patients (92%) with a median age of 18 months. Device closure failed in 2 patients (1 with aortic regurgitation and 1 with right ventricular outflow tract stenosis), and they were converted to an open operation. No severe complications (device shift, significant arrhythmia, ventricular outflow tract obstruction, or obvious valve regurgitation) were observed. There was no closure-associated valve regurgitation. No patient had worrisome progression of aortic regurgitation or pulmonary regurgitation.

Conclusions. In select patients, minimally invasive transthoracic device closure of juxtaarterial ventricular septal defects appears to be safe and effective, with good midterm outcomes.

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Juxtaarterial ventricular septal defect (VSD) is more common in Eastern races [1, 2]. Surgical repair using full median sternotomy under cardiopulmonary bypass (CPB) is the gold standard for juxtaarterial VSD, but this approach has significant morbidity and risk of death [3]. In recent years, device closure through a transcatheter approach has been introduced as an aggressive alternative to surgical closure in the treatment of VSD, but a juxtaarterial VSD is a contraindication for this treatment [4]. In our center, periventricular device closure of perimembranous VSDs with a small subxiphoid or inferior sternotomy under transesophageal echocardiography (TEE) has been performed with good results since 2007 [5–9].

For VSDs that are more than 2 mm distant from the aortic valve, the periventricular closure operation is a safe procedure with a good long-term effect [9]. An eccentric occluder can relieve the compression on the aortic valve to a great extent, and makes it possible to conduct minimally invasive transthoracic device closure of a juxtaarterial VSD. Since January 2008, we have successfully performed this periventricular closure without cardiopulmonary bypass [10]. Previous reports demonstrated the safety and efficacy of this approach [11, 12]. The present study evaluated the midterm safety and efficacy of periventricular device closure in selected patients with juxtaarterial VSD and reviewed the indications and contraindications for this new technique.

Patients and Methods

Informed consent was obtained from the parents. The study was approved by the Institutional Review Ethics Board of Women and Children's Hospital, Qingdao University.

Between January 2008 and October 2014, 25 patients with juxtaarterial VSDs underwent minimally invasive transthoracic device closure without cardiopulmonary bypass at the Heart Center of Women and Children's Hospital of Qingdao. The inclusion criterion was confirmed diagnosis of a juxtaarterial VSD by echocardiography. The exclusion criteria were (1) patient younger than 3 months old, (2) echocardiogram-confirmed obvious aortic valve prolapse (AP) greater than mild grade, (3) echocardiogram-confirmed obvious aortic

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Abbreviations and Acronyms

AP = aortic valve prolapse
AR = aortic regurgitation
CPB = cardiopulmonary bypass
ECG = electrocardiography
M = mild degree
N = normal degree
PR = pulmonary regurgitation
T = trivial grade
TEE = transesophageal echocardiography
VSD = ventricular septal defect

regurgitation (AR) greater than mild grade, (4) VSD size larger than 8 mm, (5) other associated congenital heart defect that requires surgical procedure under CPB, and (6) confirmed severe pulmonary hypertension.

Minimally invasive transthoracic device closure without CPB was performed under general anesthesia and TEE (Philips iE33, with adult X7–2 t or pediatric S7–2 t probes; Philips, Andover, MA) guidance in the operating room. The position, shape, and size of the VSD and adjacent structures, especially the aortic valve, were reassessed with TEE before the operation began, and the appropriate device and delivery system were selected (Fig 1). The occluders were from Xianjian Science and Technology Co, Ltd, Shenzhen, China, and from MicroPort, Shanghai, China.

A 3- to 4-cm lower partial median sternotomy and a 2- to 3-cm left anterior minithoracotomy were used to facilitate the operation. In our center, a left anterior minithoracotomy approach was selected with a VSD diameter of less than 6 mm. With a VSD diameter of 6 mm or larger, we preferred lower partial median sternotomy, which could be converted easily to a standard median sternotomy when transventricular VSD closure failed.

A small pericardiotomy was performed, and the pericardium was cradled to expose the free wall of the right ventricle (Fig 2). The detailed implanting steps of this technique were basically the same as described previously [7–9]. Briefly, the puncture site was determined

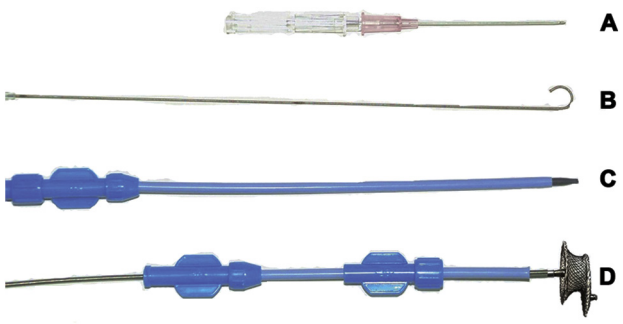

Fig 1. (A) An 18-gauge trocar; (B) 0.035-inch guide ire; (C) delivery sheath; and (D) occluder fixed on a delivery cable and in the loaded sheath.

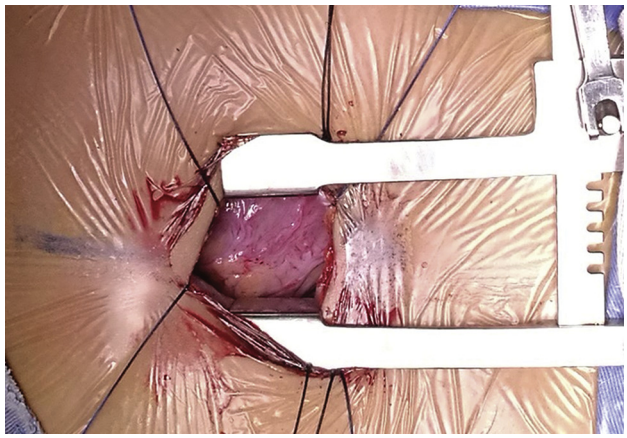

Fig 2. The free wall of the right ventricle was exposed through a 3-cm lower partial median sternotomy.

under TEE guidance. A purse string suture was placed at the puncture site, the right ventricle was punctured with an 18-gauge trocar, the needle was removed, and a 0.035-inch guidewire was passed through the puncture and the defect into the left ventricle (Fig 3). The trocar was removed, and a delivery sheath was advanced on the wire to the left ventricle. The occluder was fixed on a delivery cable, which was introduced in the delivery sheath. The left ventricle disk was deployed, and the cable was pulled until the left ventricle disk was pulled on the septum (Fig 4). The occluder was then completely deployed, as verified by TEE (Fig 5). TEE was then used to assess the presence of any undesirable changes of aortic morphology, left and right ventricular outflow tract obstruction, residual shunt, device malposition, and device-induced new regurgitation of the aortic, mitral, pulmonary, or tricuspid valves.

The patients were converted to conventional repair with CPB in the event of severe arrhythmia, such as frequent premature ventricular contractions, left bundle branch block, or complete atrioventricular block, failure to pass the guidewire through the VSD or implant the occluder, anything more than mild residual shunt, new aortic insufficiency, or more than mild tricuspid regurgitation. All patients with successful device closure were monitored in the intensive care unit until extubation, and urinalysis was performed daily for 3 days to exclude hemolysis. Anticoagulation therapy with aspirin (3 mg/kg/d by mouth) was prescribed for 3 to 6 months.

Follow-Up

Electrocardiography (ECG), transthoracic echocardiography, and chest roentgenograms were performed before discharge. Outpatient follow-up was at 1, 3, and 6 months, 1 year, and annually thereafter and included clinical examination, ECG, and transthoracic echocardiography. All patients were strictly monitored with the same standard protocol by one doctor who was specially appointed. Follow-up was censored in February 2015.