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Original article

Transcatheter closure of medium and large congenital coronary artery fistula using wire-maintaining technique

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ABSTRACT

Background: For medium and large coronary artery fistula (CAF), the initially selected device sometimes has to be exchanged by reconstruction of track wire loop due to the complexity of CAF.
Objectives: We sought to evaluate the feasibility and safety of transcatheter closure of medium and large CAF by using the wire-maintaining technique (WMT).
Methods: A total of 18 patients aged 15–56 years with congenital CAF underwent percutaneous transcatheter closure by WMT between April 2006 and October 2012. The immediate and long-term outcomes were evaluated.
Results: Of the 18 patients (11 females), 16 (88%) underwent successful transcatheter closure of fistula using WMT. The CAFs originated from the right coronary artery (67%), the left circumflex coronary artery (28%), and the left anterior descending coronary artery (5%). The drainage sites were the right ventricle (56%), right atrium (22%), left ventricle (11%), and coronary sinus (11%). The mean diameter of fistulas was 9.5 ± 1.71 mm and mean size of the devices was 13.6 ± 3.03 mm. An angiogram following device deployment showed complete occlusion in 11 patients, mild residual shunt in 2 patients, and trivial residual shunt in 3 patients. One patient had transient ST–T wave changes, and one patient had hemolysis after the procedure. Follow-up ranged from 1 month to 54 months (median 39 months). Echocardiogram showed trivial residual shunt in 3 patients at 6-month follow-up and in 1 patient at 12-month follow-up. Coronary artery thrombosis was observed in 1 patient by multislice computed tomography at 12-month follow-up.
Conclusion: For those patients with medium and large complex fistula, transcatheter closure of CAF can be performed by using the wire-maintaining technique.

Introduction

Congenital coronary artery fistula (CAF) is an abnormal communication between an epicardial coronary artery and a cardiac chamber or vascular structure located near the heart. It is a rare congenital anomaly with a reported incidence of 0.2–0.6% [1–3]. Similar to other congenital heart diseases [4], typical CAFs are often asymptomatic during childhood but adult patients are usually symptomatic. When symptomatic, the most common findings are heart failure secondary to volume overload resulting from left to right shunting, ischemia secondary to coronary steal, arrhythmia, fistula rupture or thrombosis, and infective endocarditis [5]. Medium and large fistulas generally are required to close to prevent these complications. Traditionally, surgical closure has been standard treatment of CAF. In 1983, Reidy et al. [6] first reported transcatheter closure of CAF which has become an alternative to surgical closure. The advantages of the transcatheter approach include less morbidity, lower cost, shorter recovery time, and avoidance of thoracotomy and cardiopulmonary by-pass [7]. Larger devices are usually required for closure of large to

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medium sized CAF by establishing an arteriovenous wire loop through the fistula [8]. Sometimes the initially selected device is inappropriate for the complexity of CAF. In order to change the device, the interventional cardiologist has to reconstruct the arteriovenous wire loop and reintroduce the delivery sheath, which prolongs the procedural time and increases the risk of complications. Recently a novel wire-maintaining technique (WMT) used in transcatheter closure of perimembranous ventricular septal defect was reported [9] to avoid the reconstruction of arteriovenous wire loop in patients requiring device replacement. We describe our experience with percutaneous treatment of medium and large CAF in 18 patients between 2006 and 2012 using WMT.

Methods

Patients

From April 2006 to October 2012, 18 patients (11 females) with medium and large CAF underwent transcatheter fistula closure, while those with additional complex cardiac defects requiring surgical management or with tiny CAF found incidentally during catheterization were excluded from the study. All patients underwent cardiac evaluations including history, physical examination, laboratory, and electrocardiogram (ECG). Written informed consent was obtained from all patients or their guardians prior to the procedure. Changhai Hospital institutional review board approved the present retrospective review.

Devices

Amplatzer Vascular plug and Amplatzer Vascular Plug II (AGA Medical, Golden Valley, MN, USA) and patent ductus arteriosus occluder, plug and double-disk occluder of muscular ventricular septal defect (Shanghai Shape Memory Alloy Ltd., Shanghai, China) were used. It had been explained to patients before treatment that Amplatzer Vascular plug is a safe and effective device that has been used in closure of CAF, although it does not have indication for cardiac lesions by the US Food and Drug Administration.

Procedure

Heparin was administered (100 units/kg) after the femoral venous and arterial accesses were established. After hemodynamic data were obtained, aortic root angiography and selective coronary angiography were performed to demonstrate the anatomy of the fistula, its drainage site, and identify distal coronary branches. Feasibility and approach to closure were determined by the number and location of drainage sites, the location of the proximal coronary branches, and the ability to cannulate the distal part of the fistula. To access the fistula, guiding catheter including Judkins Left, Judkins Right, extra-backup XB (Cordis, Juarez, Mexico) and 0.035-inch super smooth guidewire (Terumo, Tokyo, Japan) were used. Devices were deployed either via the femoral artery or femoral vein, using a track wire loop (via femoral artery and femoral vein). The WMT reported previously [9] was used during the procedure. In brief, the track wire loop was maintained in the delivery sheath during the occluder insertion and deployment. Even if the initial occluder was inappropriate, the delivery sheath could be reintroduced over the maintained wire after withdrawal of the occluder, and the reconstruction of track wire loop was avoided (Fig. 1). Devices were selected by the operator based on the size and other characteristics of the fistula. During temporary occlusion at the proposed site of device deployment, ECG was monitored for up to 15 min to assess for ischemia. After the appropriate size and proper position of the occluder were confirmed by coronary angiogram, the track wire was then withdrawn gently from the femoral artery by fixing the push rod and delivery sheath. Finally, with confirmation of normal echocardiographic and ECG parameters, the device was released. Selective coronary angiography was performed immediately after device deployment to assess the presence of residual shunt. The degree of residual shunt was defined as trivial (shunt <1 mm), mild (1–2 mm), moderate (3–4 mm), and severe (>4 mm). Postoperatively patients without further complications received aspirin (3–5 mg/kg) or warfarin based on the size of CAF for 6 months.

Follow-up

ECG, echocardiogram, and chest radiograph were performed 24 h after the procedure. Each patient who underwent successful CAF closure was followed up clinically by ECG and echocardiogram at 1, 3, 6, and 12 months. A residual shunt was considered to be present if color-Doppler flow mapping showed a shunt. It was classified as follows: trivial (1 mm color jet width), mild (1–2 mm), moderate (2–4 mm), or large (4 mm). Multislice computed tomography (MSCT) was performed at 12 months.

Data analysis

Continuous variables are reported as mean $\pm$ SD or median and range, as appropriate. For proportions, numbers and percentages are used. Statistical analysis was performed using SPSS version 17.

Results

Of 18 patients, 16 underwent successful CAF closure by using WMT and occluders were exchanged in 5 patients. Two patients had unsuccessful procedures due to extreme vessel tortuosity with inability to cannulate the distal fistula. At the time of operation, the mean age was 30.7 ± 10.9 years (range, 15–56 years). Details of the patients are shown in Table 1. The most common symptoms were exertional dyspnea in 9 patients, chest pain in 3 patients, and heart failure in 1 patient. A continuous systolic–diastolic murmur was present in 13 patients. All patients received antiplatelet therapy before intervention. ECG showed left ventricular hypertrophy in 2 patients and nonspecific ST- and T-wave changes in 4 patients. CAF origin and drainage site are shown in Table 1. Origin from the right coronary artery (RCA) was the most common origin, followed by the circumflex artery, and the left anterior descending coronary artery. The fistula drained most commonly into the right ventricle. There was no significant atherosclerotic disease noticed in the coronary arteries.

The mean diameter of the fistulas was 9.5 ± 1.71 mm, and the mean size of devices was 13.6 ± 3.03 mm (Table 1). Immediate post-deployment angiography documented complete occlusion in 11 patients, mild residual flow in 2 patients, and trivial residual flow in 3 patients. The fluoroscopy time was 25.4 ± 6.4 min and the procedure time was 96.3 ± 24.6 min. There were transient ST-T wave changes during positioning of the delivery sheath that resolved following withdrawal of the sheath. Transient hemolysis occurred in 1 patient (#14) with a large distal-type fistula from RCA to left ventricle and treated with a 12-mm double umbrella device (double-disk occluder of muscular ventricular septal defect) with mild residual shunt by angiogram and who was successfully treated with intravenous infusion of normal saline and dexamethasone (10 mg daily) and oral sodium bicarbonate to prevent acute kidney injury without blood transfusion and recovered a week later. He did not receive antiplatelet therapy postoperatively.

Follow-up ranged from 1 month to 54 months (median 39 months). At the 1-, 3-, 6-month and 1-year follow-up