Transconduit puncture for catheter ablation of atrial tachycardia in a patient with extracardiac Fontan palliation

Amish S. Dave, MD, PhD, Jamil Aboulhosn, MD, John S. Child, MD, FACC, Kalyanam Shivkumar, MD, PhD, FACC, FHRS

From the UCLA Cardiac Arrhythmia Center and Ahmanson UCLA Adult Congenital Heart Disease Center, David Geffen School of Medicine at UCLA, Los Angeles, California.

Introduction

Fontan palliation and its variants are the most widely used and accepted approach for regulating pulmonary blood flow and relieving cyanosis in patients with single-ventricle physiology.[1] First-generation Fontan procedures involved connection of the right atrium (RA) to the pulmonary artery (PA). However, this frequently caused RA dilation, sluggish RA flow, and atrial fibrosis and was associated with a high incidence of atrial arrhythmias.[2,3] Exclusion of most or all of the RA decreases the incidence of atrial arrhythmias; therefore, the Fontan procedure evolved with the establishment of a total cavopulmonary connection by way of either the lateral tunnel (an intra-atrial tunnel) or the extracardiac Fontan.[4,5] Patients who have undergone first-generation RA–PA Fontan surgery with subsequent development of atrial arrhythmias may benefit from surgical conversion to total cavopulmonary connection with concomitant arrhythmia surgery.[6,7] Despite a significant reduction in arrhythmia burden, a subgroup of patients still develop recurrent arrhythmias.[8] The extracardiac Fontan consists of an inferior vena cava to PA conduit and direct connection of the superior vena cava to the PA. As the procedure is performed completely outside the heart, it is thought to be associated with fewer arrhythmic sequelae.[9] However, the conduit is made of stiff Gore-Tex, which precludes access into the heart. This report outlines an approach to catheter ablation in a patient with extracardiac Fontan palliation in which the heart was accessed via the conduit.

Case report

The patient was a 34-year-old man with functionally single (left) ventricle, tricuspid atresia but no pulmonary stenosis/atresia, atrial septal defect, ventricular septal defect, and D-transposition of the great arteries in situs solitus (S,D,D). He had undergone PA banding at age 8 months. At age 7 years, this band was loosened, and his ventricular septal defect was enlarged. At age 15 years, he underwent nonvalved modified Fontan anastomosis of RA to PA with pericardial augmentation, atrial septal defect closure, and further enlargement of the ventricular septal defect. A few years later, he began having palpitations, which occurred about once weekly, lasted up to 30 seconds, and were associated with dyspnea but not with syncope or presyncope. In 2005, at age 30 years, due to reduced exercise tolerance he underwent revision to an extracardiac nonfenestrated Fontan, a bidirectional Glenn, and resection of subaortic stenosis (Figure 1). This surgery involved resection of the atrial septum, resulting in a single pulmonary venous atrium with "right" and "left" atrial portions. Con-

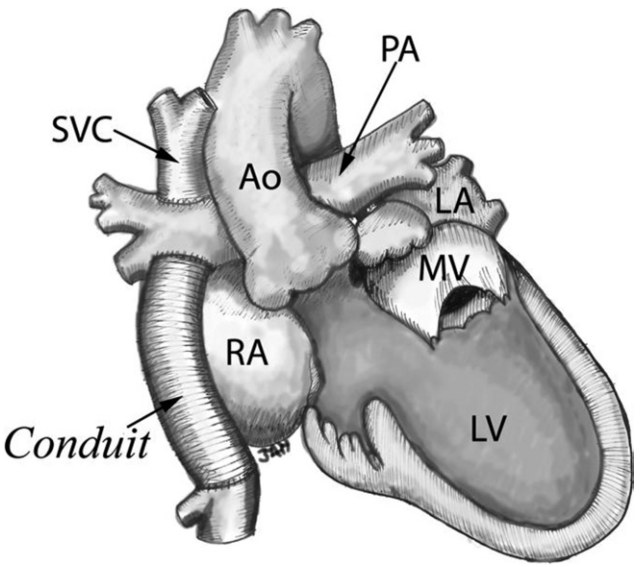

Figure 1 Postsurgical anatomy. Tricuspid valve atresia with hypoplastic right ventricle and well-developed systemic left ventricle (LV) are seen. Great arteries are D-transposed with the aorta (Ao) anteriorly dextraposed and the banded pulmonary artery (PA) posteriorly levoposed. Superior vena cava (SVC) is connected to PA via bidirectional Glenn shunt. Extracardiac conduit connects inferior vena cava to PA. Note close proximity of extracardiac conduit to "right atrial" portion (RA) of pulmonary venous atrium. LA = "left atrium"; MV = mitral valve.

KEYWORDS Catheter ablation; Conduit puncture; Electrocautery; Fontan surgery

ABBREVIATIONS **PA** = pulmonary artery; **RA** = right atrium (Heart Rhythm 2010;7:413–416)

This work was supported by National Heart, Lung, and Blood Institutes Grants R01-HL084261 and R01-HL067647 to Dr. Shivkumar. **Address reprint requests and correspondence:** Dr. Kalyanam Shivkumar, UCLA Cardiac Arrhythmia Center, Ronald Reagan UCLA Medical Center, David Geffen School of Medicine at UCLA, 47-123 CHS, 10833 Le Conte Avenue, Los Angeles, California 90095. E-mail address: kshivkumar@mednet.ucla.edu. (Received September 25, 2009; accepted October 29, 2009.)

 doi:10.1016/j.hrthm.2009.10.037

comitant arrhythmia surgery was not performed. The patient's exercise tolerance subsequently improved significantly. Following surgery, his atrial arrhythmias were treated successfully with amiodarone. In 2008, the amiodarone was stopped because of the patient's elevated liver enzyme levels. The patient was switched to dofetilide, which was ineffective. His palpitations progressively increased to several times per week and lasted for minutes each. The episodes were sudden in onset and offset and were associated with significant dyspnea. He continued to be free of syncope. Holter monitoring revealed predominantly atrial tachycardia and rare episodes of atrial fibrillation. In April 2009, the patient underwent cardiac catheterization, plug occlusion of a large venous collateral, and electrophysiologic testing, which showed an atrial tachycardia with a cycle length of 472 ms. This tachycardia was easily inducible with burst atrial pacing at the inferior vena cava–conduit junction at 400-ms cycle length. Cardiac magnetic resonance imaging showed close apposition of the extracardiac conduit and the free wall of the right atrial portion of the pulmonary venous atrium (RA).

The patient was referred for catheter ablation. Conduit angiography was performed (Figure 2A). Intravenous heparin was administered to achieve an activated clotting time >300 seconds and was given prior to transconduit puncture to minimize the risk of clot formation (standard for all transseptal access procedures in our laboratory). Protamine was kept ready in case of perforation or significant bleeding. The tip of an SL-0 sheath with a 71-cm Brockenbrough (BRK-1) needle (St. Jude Medical, Minnetonka, MN, USA) inside of it was positioned along the left border of the conduit adjacent to the RA. Correct positioning was confirmed with biplane fluoroscopy; transesophageal echocardiography and intracardiac echocardiography were less useful for this step. The needle was advanced but would not cross readily through the Gore-Tex conduit material. Multiple advances were made with radiofrequency energy (Valley Lab, Boulder, CO, USA) of 45 W and 90 W using the "cut" setting. A second needle was required when the first needle was found to have been bent. Using a combination of constant forward pressure and radiofrequency energy, the BRK-1 needle was able to cross the conduit, and contrast injection showed staining of the conduit and atrial myocardium (Figure 2B). A 0.032-inch Toray valvuloplasty wire (Toray Corporation, Tokyo, Japan) was advanced through the SL-0 sheath into the atrium. The dilator crossed into the atrium over the Toray wire, but the sheath would not readily cross (Figure 2C). The sheath and dilator were exchanged for an Agilis 8.5Fr sheath (St. Jude Medical, Minnetonka, MN, USA). Again the dilator crossed, but the sheath would not track over the dilator. With the Toray wire and no dilator in place, the patient's hemodynamics were stable, and no effusion/hemothorax was noted on transesophageal echocardiography. A 4-mm × 20-mm peripheral percutaneous transluminal angioplasty balloon (OPTA Pro, Cordis Endovascular, USA) was advanced over the Toray wire and positioned to straddle the border between the extracardiac conduit and the atrium (Figure 2D). Two inflations were performed at 6 atm and 8 atm for 10 seconds each. Following balloon dilation, the SL-0 sheath was able to cross readily. Atrial position was confirmed with contrast injection. Transesophageal echocardiography and intracardiac echocardiography showed no evidence of bleeding. A Berman angiographic balloon-tipped catheter (Arrow International, Reading, PA, USA) was advanced through the SL-0 sheath into the atrium, and cine angiography was performed (Figure 2E).

A deflectable tip duodecapolar catheter was positioned across the aortic valve into the (left) ventricle. A 3.5-mm-tip externally irrigated radiofrequency ablation catheter (Cel-

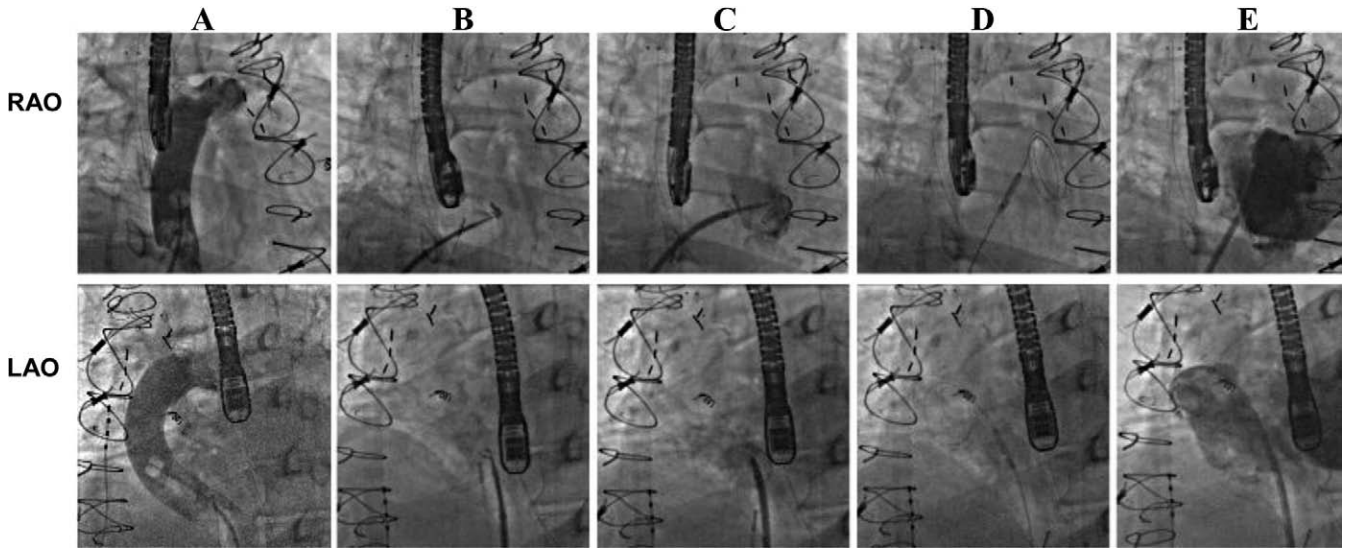

Figure 2 Fluoroscopic images showing still frame from conduit angiogram **(A),** transseptal needle with contrast staining of conduit prior to crossing **(B),** dilator of transseptal sheath crossing conduit into pulmonary venous atrium **(C),** Toray valvuloplasty wire coiled in atrium with angioplasty balloon inflated across conduit crossing **(D),** and still frame from angiography of pulmonary venous atrium **(E).** LAO = left anterior oblique; RAO = right anterior oblique.