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Letter to the Editor
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Successful Ablation of Ventricular Tachycardia in Repaired Tetralogy of Fallot via Transjugular and Subclavian Approach

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Key Words: Intracardiac echocardiography • Superior approach • Tetralogy of Fallot • Three-dimensional reconstruction • Ventricular tachycardia

INTRODUCTION

Tetralogy of Fallot (TOF) is the most common cyanotic congenital heart disease. Surgical repair with ventricular septal defect (VSD) patch and right ventricular outflow tract (RVOT) reconstruction is the only curative therapy. The population of adults with repaired Tetralogy of Fallot (rTOF) is growing due to the improvement of surgical technique. As a consequence, the increase burden of age-dependent ventricular arrhythmias (VAs) in patients with rTOF becomes an important reason for late morbidity and mortality. Notably, the vast majority of VAs in patients with rTOF are monomorphic ventricular tachycardias (VTs).[1] Given the better understanding of the potential 4 anatomic isthmuses for VT circuits,[2] catheter ablation has been implemented to be an effective and curative strategy to manage VTs in patients with rTOF, while clinical approaches are frequently achieved using femoral vein. However, clinical hurdle persisted once if patients with rTOF had limited vascular access. Here, we reported a challenging case with difficult vascular access owing to multiple occluded thrombosis and successful ablation of multiple monomorphic VT was performed using superior approach guided by merged intracardiac echocardiography (ICE) and reconstructed cardiac computed tomography (CT) image reconstruction in a case of rTOF.

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CASE

A 16-year-old male with a history of TOF received multiple surgical repairs and epicardial pacemaker implantation for atrioventricular node dysfunction. He presented with palpitation and near syncope since age of fifteen. Several episodes of sustained monomorphic VT with left bundle branch block (LBBB) and inferior axis were documented (Figure 1A). He was referred for catheter ablation of drug-refractory VTs. After obtaining informed consent, an electrophysiological study and ablation was performed via left subclavian and left internal jugular vein owing to bilateral iliac veins and right internal jugular vein occlusion. Pre-operative three-dimensional (3D) cardiac model, including surgical patch of ventricular septal defect, bioprosthetic pulmonary valve, and biventricular pacing leads, was reconstructed by Mimics 19.0 (Materialize, Leuven, Belgium) using cardiac CT images. During the procedure, the cardiac model was merged with real-time 3D image created by CartoSound® system (Figure 1B) and electroanatomic mapping. The bipolar scar and low voltage zone (voltage threshold < 0.5 mV for bipolar scar and 0.5-1.5 for bipolar low voltage zone) was located at basal right ventricle (RV) and RVOT, where late and fractionated potentials were recorded. The activation map (Figure 1C), entrainment and pacemapping of the clinically-documented sustained VT demonstrated that the circuit was located at the anatomic isthmus surrounding the tricuspid annulus and RVOT patch, whilst the nonclinical sustained VT with LBBB and superior axis were originated from the basal inferior free wall adjacent to the surgical scar. In order to achieve adequate tissue contact, radiofrequency (RF) ablation was performed using looping technique of ablation catheter (Thermocool, Biosense Webster, CA, US) to transect the isthmuses and eliminate all the late and fractionated potentials (Figure 2), which rendered the VTs non-inducible at the end of the procedures under the same programmed stimulation. To prevent future sudden cardiac death given the potentially life-threatening ventricular tachyarrhythmias, the patient received an implantable cardioverter defibrillator

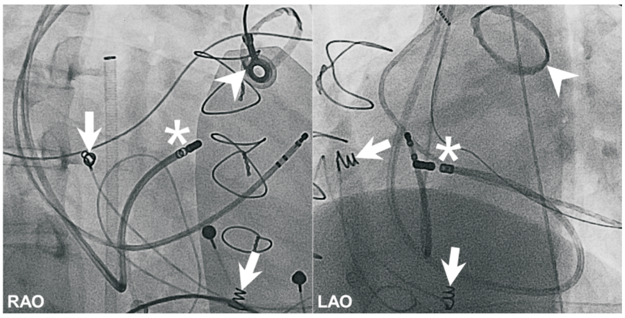

Figure 2. *Flouroscopic images of successful ablation site was over basal superior free wall of right ventricle by looping method. Arrow head, tissue pulmonary valve; arrow, epicardial leads; Asterisk, ablation catheter; LAO, left anterior oblique; RAO, right anterior oblique.*

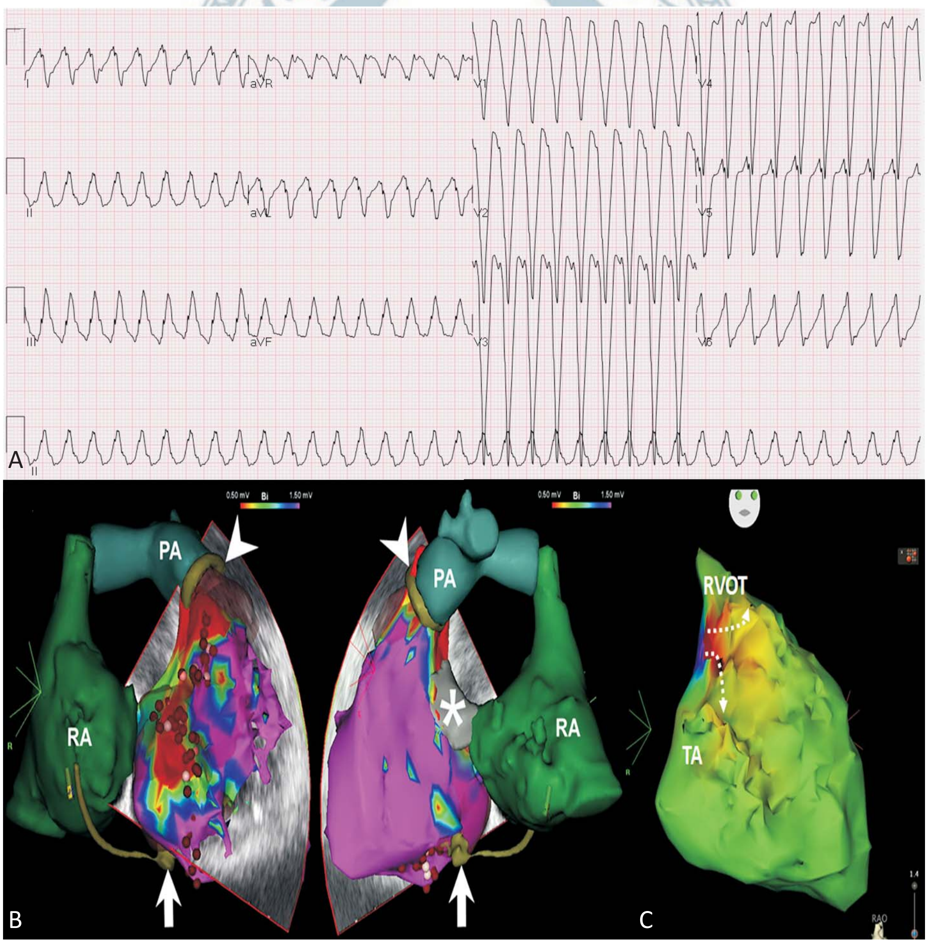

Figure 1. *Clinical sustained monomorphic VT with features of left bundle branch block and inferior axis (A). The electroanatomic map of right ventricle created by CartoSound system and Thermocool catheter was merged with the three-dimensional reconstruction of ventricular septal defect (VSD) patch (asterisk), tissue pulmonary valve (arrow head), and epicardial lead (arrow) from computed tomography images (B). The activation map of clinical VT demonstrated that the VT isthmus was located between the free wall of RVOT and tricuspid annulus (C). PA, pulmonary artery; RA, right atrium; RVOT, right ventricular outflow tract; TA, tricuspid annulus; VT, ventricular tachycardia.*

(ICD) implantation after ablation. The patient was uneventful for VT recurrences during a follow-up period of 12 months.

DISCUSSION

In patients with TOF with VT, there are four anatomic isthmuses (AIs) which are bounded by unexcitable tissue from tricuspid and pulmonary annulus, RVOT transannulus patch, RV incision, and VSD patch. These four isthmuses are defined as areas between (1) the tricuspid annulus and scar/patch in the anterior right ventricular outflow, (2) the pulmonary annulus and right ventricular free wall scar/patch, (3) the pulmonary annulus and septal scar/patch, and (4) the septal scar/patch and tricuspid annulus.[2] The role of these AIs can be regarded as critical isthmuses of the reentry circuit of the VT. In our case, the VT circuit utilized the AI between tricuspid annulus and transannulus patch. Using superior approach, it will easier to contact the AIs nearby pulmonary valve (isthmus 2 and 3). However, for AIs adjacent to the tricuspid annulus (isthmus 1 and 4), an adequate catheter contact will be difficult to achieve than inferior approach in spite of the assistance of deflectable sheath. Using the looping technique, the shaft of the catheter can be anchored at the opposite site of the tricuspid annulus and the contact of ablation tip at the free wall via superior approach will be improved. Furthermore, in spite of the successful ablation, given the probabilistic of recurrent life-threatening events, an ICD implantation should be mandatory in the rTOF patients with documented ventricular tachyarrhythmias.[3]

Aside from the above, owing to the difficulty in manipulation of the catheter using superior approach, the incorporation of 3D reconstruction image from CT and ICE will be clinically important to prevent incomplete electroanatomic map given the detailed formation of the anatomic shell. Through the delineation of the VSD patch, pulmonary annulus, tricuspid annulus, and epicardial leads from CT images with 3D reconstruction, the Ais between VSD patch and tricuspid or pulmonary annulus can be easily localized, while the AIs between RVOT/RV scar and tricuspid or pulmonary annulus, the RVOT or RV scar can only be identified by electroanatomic map[4] and high-output pacing.[5] Therefore, real-time ICE can provide an useful information regarding the tissue contact and the completion of substrate assessment, the scar area by regional motion abnormality or echogenicity, which could facilitate the scar delineation.[6]

When an obstruction of iliofemoral venous system or absence of inferior vena cava occurs, superior vena cava (SVC) approach or transhepatic access can be the alternative vascular choices. Transhepatic access is more technique dependent and carries the risk of bleeding, infection and pneumothorax,[7] while previous reports demonstrated that SVC approach could be implemented for several kinds of atrial arrhythmias, such as atrial fibrillation, Wolff-Parkinson-White syndrome, atrioventricular nodal reentrant tachycardia, and typical atrial flutter.[8-11] However, the disadvantages of SVC approach include less familiarity with catheter manipulation and stability; adequate contact of tissue, more difficulty in the transseptal puncture; less compressible puncture sites for hemostasis.[7] The present case firstly demonstrated the feasibility of VT ablation of RV free wall VT via left subclavian approach with looping technique to achieve better tissue contact.

In conclusion, this is the first report to illustrate a successful ablation of VTs in TOF patients through superior approach owing to the limited vascular access, special manipulation technique of ablation catheter and the incorporation of multi-discipline images.

LEARNING POINTS

Substrate ventricular tachycardia with critical isthmus in RV can be successfully ablated via superior approach with multi-modality of image guidance. 3D reconstruction of VSD patch, prosthetic pulmonary valve annulus, and epicardial leads can facilitate the anatomic isthmus identification during the ablation.

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DECLARATION OF CONFLICT OF INTEREST

All the authors declare no conflict of interest.

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