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Catheter ablation of idiopathic ventricular tachycardia without the use of fluoroscopy☆

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ABSTRACT

Background: Catheter ablation is the treatment of choice for many patients with idiopathic ventricular tachycardia (VT). Unfortunately, conventional catheter ablation is guided by fluoroscopy, which is associated with a small but definite radiation risk for patients and laboratory personnel. The aim of our study is to assess feasibility, success rate and safety of idiopathic VT ablation procedure performed without the use of fluoroscopy.
Methods: Nineteen consecutive patients undergoing idiopathic VT ablation at our institution have been included. The ablation procedures were performed under the guidance of electroanatomical mapping (EAM) system and intracardiac echocardiography (ICE).
Results: Nineteen patients (mean age 38.7 years) underwent ablation procedure for idiopathic VT. Twelve (63%) had outflow tract VT, 3 (18%) fascicular tachycardia, 2 (11%) peri-tricuspidal VT, 1 (5%) peri-mitral VT, and 1 (5%) lateral left free-wall VT. The mean procedural time was 170.2 ± 45.7 min. No fluoroscopy was used in any procedural phase. Acute success rate was 100%. No complication was documented in any patients. After a mean follow up of 18 ± 4 months, recurrences occurred in 2 patients.
Conclusions: In our preliminary experience idiopathic VT ablation without the use of fluoroscopy was feasible and safe, using a combination of EAM and ICE. Success rate was excellent with no complication.

1. Introduction

Catheter ablation is the treatment of choice for many patients with idiopathic ventricular tachycardia/premature ventricular contractions (VT/PVC). The success rate for this procedure is greater than 90% for most substrates. Conventional catheter ablation employing fluoroscopy is associated with a small but definite radiation risk for patients and laboratory personnel [1,2]. These risks are heightened in case of lengthy and multiple ablation procedures (eg, atrial fibrillation) and, in particular, among vulnerable patients such as pediatric, obese, and pregnant patients [3,4]. For complex/lengthy electrophysiology procedures, 1 h of fluoroscopy is associated with an increase in lifetime risk of fatal malignancy of 0.07% for female and 0.1% for male patients [5]. Although the attributable risk seems small, it is important to recall that fluoroscopy exposure is additive and is not limited to the electrophysiology laboratory. Emphasizing the importance of minimizing radiation exposure during cardiac interventions, the American College of Cardiology has promoted the ALARA principle: keep fluoroscopic exposure to a level "as low as reasonably achievable" [6]. The advent of electroanatomic mapping (EAM) systems, that are able to map cardiac chambers and simultaneously visualize multiple catheters, has allowed to lower the use of fluoroscopy during electrophysiology procedures [7,8]. Further fluoroscopy reduction, or even elimination, can be obtained combining these techniques with other imaging modalities such as intracardiac echocardiography (ICE) or transesophageal echocardiography (TEE). Several authors have reported their experience with ablation of supraventricular tachycardia substrates on the right and left sides of the heart without the use of fluoroscopy with a success rate overlapping that of standard procedures and with a very low incidence of complications [9–12]. Even in more "complex procedures" such as atrial fibrillation ablation (AF) a non-fluoroscopic approach was demonstrated to be feasible and safe, combining ICE and EAM system [13].

In the present study, we report our experience of attempting to completely eliminate fluoroscopy during catheter ablation procedure for idiopathic VT, using EAM in conjunction with ICE.

2. Methods

From January 2011 a "zero-fluoroscopy" catheter ablation program was started at our center including procedures for supraventricular

☆ All authors take responsibility for all aspects of the reliability and freedom from bias of the data presented and their discussed interpretation.

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and ventricular arrhythmias. Nineteen consecutive patients with idiopathic VT/PVC and candidate to catheter ablation were treated with a fluoroless approach and included in this report. Written informed consent was obtained from patients or their parents. The study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki as reflected in a priori approval by the institution's human research committee.

Antiarrhythmic drugs were discontinued before catheter ablation based on their half-time.

All the procedures were performed under conscious sedation using bolus of fentanyl and midazolam. Since the beginning of the procedure, X ray apparatus was left off and all of the medical and nursing staff did not wear lead aprons.

2.1. Catheter positioning and electrophysiological study

After standard femoral access, a 3.5-mm externally irrigated radiofrequency (RF) ablation catheter (Thermocool SF; Biosense-Webster, Inc., Diamond Bar, CA) was advanced into the inferior vena cava (IVC) under EAM system guidance (CARTO 3, Biosense-Webster, Inc., Diamond Bar, CA). Three dimensional (3D) geometric contours of the IVC were created by sweeping the catheter tip while advancing it up to the initial appearance of atrial electrograms that denoted the junction between the IVC and the right atrium (RA). Any difficulties in catheter advancement were overcome with a geometric acquisition of the trajectory of the catheter through the venous system (Fig. 1, panel A). Ultimately, the catheter was advanced to the RA in order to delineate its border, tagging the area where a His deflection was recorded and reproducing in detail the tricuspidal annulus. In patients with outflow tract VT the coronary sinus (CS) was reconstructed up to its distal portion. Once the 3D shell of the RA was obtained, two quadripolar catheters were advanced in the RA and positioned respectively in the His bundle region and in the right ventricle (RV) using the right and left anterior oblique views of the EAM system (Movie 1; Fig. 1, panel B). In the same manner, a decapolar deflectable catheter was advanced in the distal CS if required (Movie 2; Fig. 1, panel B). Standard ventricular stimulation was performed to induce VT. Isoproterenol infusion up to 5 γ/min was used if necessary.

2.2. ICE chamber reconstruction

Then a 10-Fr ICE catheter (Soundstar, Biosense-Webster, Inc., Diamond Bar, CA) was inserted through the left femoral vein, advanced up to the RA and then rotated and manipulated in order to visualize multiple echo sections. Sequential ICE contours of the right and/or the left ventricle were acquired in order to create a 3D shell of the chambers using the CartoSound™ module (Biosense-Webster, Inc., Diamond Bar, CA) that allows the integration of ICE and EAM system 3D maps. Particularly, when required, detailed imaging of the right ventricular outflow tract (RVOT), pulmonary valve, aortic root, aortic valve and left ventricular outflow tract (LVOT) was obtained. The origin of the coronary arteries was marked on the reconstructed 3D echo shell when necessary.

2.3. Mapping and ablation

The 3D ICE shells of the ventricles were used for catheter manipulation in order to create a 3D electro-anatomic activation map focused on the area of interest (Fig. 2). In case of outflow tract VT, EAM of both LVOT and RVOT was performed. Moreover, in this setting, intracardiac signals from the distal CS were always recorded. Left ventricle (LV) was mapped, when required, with retrograde trans-aortic approach. In detail 3D shell of the aorta was obtained while advancing the ablation catheter in the vessel from the femoral artery. Once the catheter reached the aortic arch, its distal portion was looped and then advanced in the aortic root, to avoid the engagement of the left main coronary artery. Moreover, at this point, the direct visualization of the catheter enabled by ICE was used in order to safely cross the valve [14].

The electro-anatomic activation map was obtained annotating the earliest local activation during PVC or VT. Maximum voltage value of surface ECG was selected as reference. Local earliest activation combined with sharp negative deflection (QS) in the unipolar derivation and optimal pace mapping (12/12 leads) was used to guide the ablation. Abnormal Purkinje potentials (PP) in sinus rhythm or during ventricular tachycardia were used to guide the ablation of fascicular VT (Fig. 3); if idiopathic left ventricular tachycardia (ILVT) was not inducible or sustainable, a linear lesion was created at the level of the posterior fascicle [15] or, if necessary, left posterior fascicle block was targeted [16].

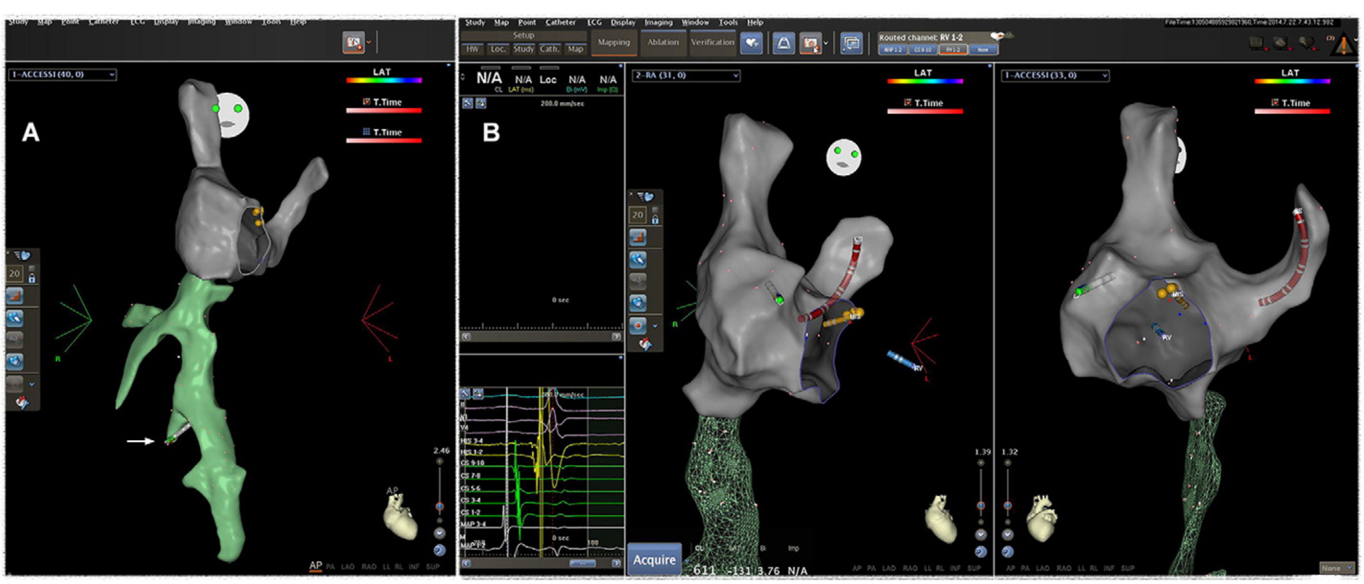

Fig. 1. Panel A shows the anteroposterior view of the 3 D reconstruction the RA and the IVC using the CARTO 3 system. Geometric contours of the IVC, including various branches inadvertently engaged (white arrow), are created by sweeping the ablation catheter tip. As the catheter is manipulated in the RA and SVC, the RA geometry becomes evident. As the lower septal aspect of the RA is probed, the CS is engaged and then reconstructed up to its distal portion. Yellow tag points represent the area where the His bundle deflection is recorded. Panel B shows the right (on the left) and left (on the right) anterior oblique views of the 3D reconstruction of the RA, with the two quadripolar catheters positioned respectively in the His bundle region (yellow catheter) and in the right ventricle (blue catheter) and the multipolar catheter (red catheter) in the coronary sinus. To better appreciate real-time catheter movement, two videos are included as an online supplement (Movies 1 and 2); these videos show the diagnostic catheters positioning.