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Remote magnetic navigation facilitates the ablations of frequent ventricular premature complexes originating from the outflow tract and the valve annulus as compared to manual control navigation

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ABSTRACT

Objective: The purpose of this study was to assess the role of remote magnetic navigation (RMN) in the ablation of ventricular premature complexes (VPCs) arising from outflow tracts (OT) and valve annuli by comparing to manual control navigation (MCN).
Methods: A total of 152 patients with frequent VPCs were prospectively enrolled. 64 (42%) patients underwent ablation guided by RMN. Acute success rate was defined as the complete elimination and non-inducibility of clinical VPCs during the procedure.
Results: Overall, acute success rate of RMN group was not different from MCN group (87.5% vs 84.1%, $p = 0.56$). Compared to MCN group, the fluoroscopic time of OT-VPCs ablation in the RMN group was significantly reduced by 67% (2.9 ± 2.3 min vs 8.9 ± 9.7 min, $p = 0.006$), and the ablation applications in successful cases were significantly reduced (11 ± 7 vs 15 ± 11, $p = 0.018$). Compared to MCN, RMN significantly decreased ablation applications (15 ± 9 vs 23 ± 9, $p = 0.013$) in the acute success rates of ablating VPCs of valve annulus, and has a trend of a higher success rate for VPCs arising from tricuspid annulus (10/11 vs 7/12, $p = 0.193$). No complications occurred in the RMN group. Three cases of cardiac tamponade and one case of transient atrioventricular block occurred in the MCN group ($p = 0.22$). After a mean follow up of 16.2 months, 2/56 and 3/74 patients had a recurrence of VPCs in the RMN group and MCN group respectively ($p = 0.75$).
Conclusions: When compared to MCN, RMN-guided ablation for VPCs was just as effective and safe, with the added benefit of reduced fluoroscopic time and fewer ablation applications.

1. Introduction

Catheter ablation has been accepted as curative treatment for patients with medically refractory idiopathic ventricular arrhythmias (VAs) including frequent ventricular premature complexes (VPCs) and ventricular tachycardia (VT). Acute success rates have been reported in excess of 80% [1–4]. However, manual catheter navigation (MCN) within the ventricles can be technically challenging due to catheter stiffness, complicated by the potential risks of perforation, which is reported in 1–5% of cases [5,6], and lead to unsuccessful ablation. These failures frequently exist in difficult anatomies, including origins from the mitral annulus (MA), tricuspid annulus (TA), left ventricular (LV) papillary muscles, LV summit and aortomitral continuity (AMC), which may be from poor catheter contact and insufficient lesions. Remote magnetic navigation (RMN) has been successfully used for the ablations of particularly challenging VAs [7,8]. Because of the soft-tipped catheter, RMN system can facilitate navigation to reach the above mentioned difficult anatomic locations with superior stability. The purpose of our study was to evaluate the advantages and the long-term clinical outcomes of catheter ablation guided by RMN for frequent VPCs originating from outflow tract (OT), MAs and TAs compared to MCN.

2. Methods

2.1. Patient characteristics

In this prospective observational study, 152 patients with symptomatic and medically refractory VPCs arising from OT and valve annulus (MAs and TAs), with no prior ablation, were consecutively included between January 2015 and June 2017 at our institution. All patients signed an informed consent before the procedure. All patients were divided into two groups: RMN group or MCN group. Patients with structural heart disease including coronary artery disease, valvular heart disease or congenital heart disease were excluded from this study.

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2.2. Electrophysiological study protocol

After withdrawal of antiarrhythmic drugs for five half-lives, electrophysiology studies were performed with patients in the fasting, conscious state. In all patients, a deca-polar catheter (St Jude Medical, Inc.) and a bi-polar catheter (St Jude Medical, Inc.) were placed within the coronary sinus and at the apex of the right ventricle via the left internal jugular vein and left femoral vein respectively. Twelve lead surface ECGs and intracardiac electrograms were recorded simultaneously by a digital multichannel mapping system, filtered at 30 to 400 Hz for bipolar electrograms and at 0.05 to 400 Hz for unipolar electrograms. If clinical VPCs failed to occur spontaneously, intravenous isoproterenol infusion (1–10μg/min) was administrated to induce VPCs. A single bolus of 50–100 IU/kg body weight of heparin was administrated if mapping and ablation were necessary during the procedure. Additional heparin was administrated to maintain an activated clotting time between 200 and 250 s as required.

2.3. Mapping and ablation strategy

Patients in both groups underwent point-by-point electro-anatomical mapping using CARTO™ 3D mapping system (Biosense Webster). In the RMN group, an open-irrigated magnetic ablation catheter (NaviStar™ RMT ThermoCool™, Biosense Webster Inc.) was connected with the mapping system and the RMN Niobe™ ES (QUIK-CAS, Stereotaxis Inc., St. Louis, MO) to perform 3D LV electro-anatomic mapping and ablation. For VPCs arising from the right ventricle (RV), a Swartz sheath (SR0, St. Jude Medical Inc.) was positioned between the inferior vena cava and the TA via the right femoral vein. For VPCs arising from superior MAs or sub-aortic valves in the RMN group, the ablation catheter was manipulated with a reverse "S" curve via a transseptal approach (Fig. 1). The RMN catheter was introduced into the LV cavity using a steerable sheath (MobiCath, Biosense Webster Inc. or Agilis™, St. Jude Medical Inc.). A retrograde transaortic approach was necessary for the mapping and ablation of VPCs from the aortic root in the RMN group. In the MCN group, an open irrigated ablation catheter (Thermocool SmartTouch, Biosense Webster Inc.) was used. VPCs either from LVOTs or MAs were mapped and ablated via a retrograde transaortic approach. For VPCs arising from RVOT or TAs, a Swartz fixed sheath was used in the MCN group, if necessary.

We selected optimal ablation sites by both identifying the site of earliest ventricular activation and by pace mapping. Ablation was initiated if the following criteria were met: local activation was at least 20 ms pre-QRS, 11 of 12 ECG matched during pace mapping, and unipolar electrograms assumed QS morphology. Radiofrequency energy was delivered in the temperature control mode with target tissue temperature of <43 °C. Power was set at 30–40 W with a flush rate of 17–25 mL/min.

2.4. Complications

Complications were divided into two categories: major and minor. Major complications included cardiac tamponade, acute myocardial infarction, permanent AV block, stroke and major bleeding. Minor complications were defined as pericarditis, transient AV block and inguinal haematoma.

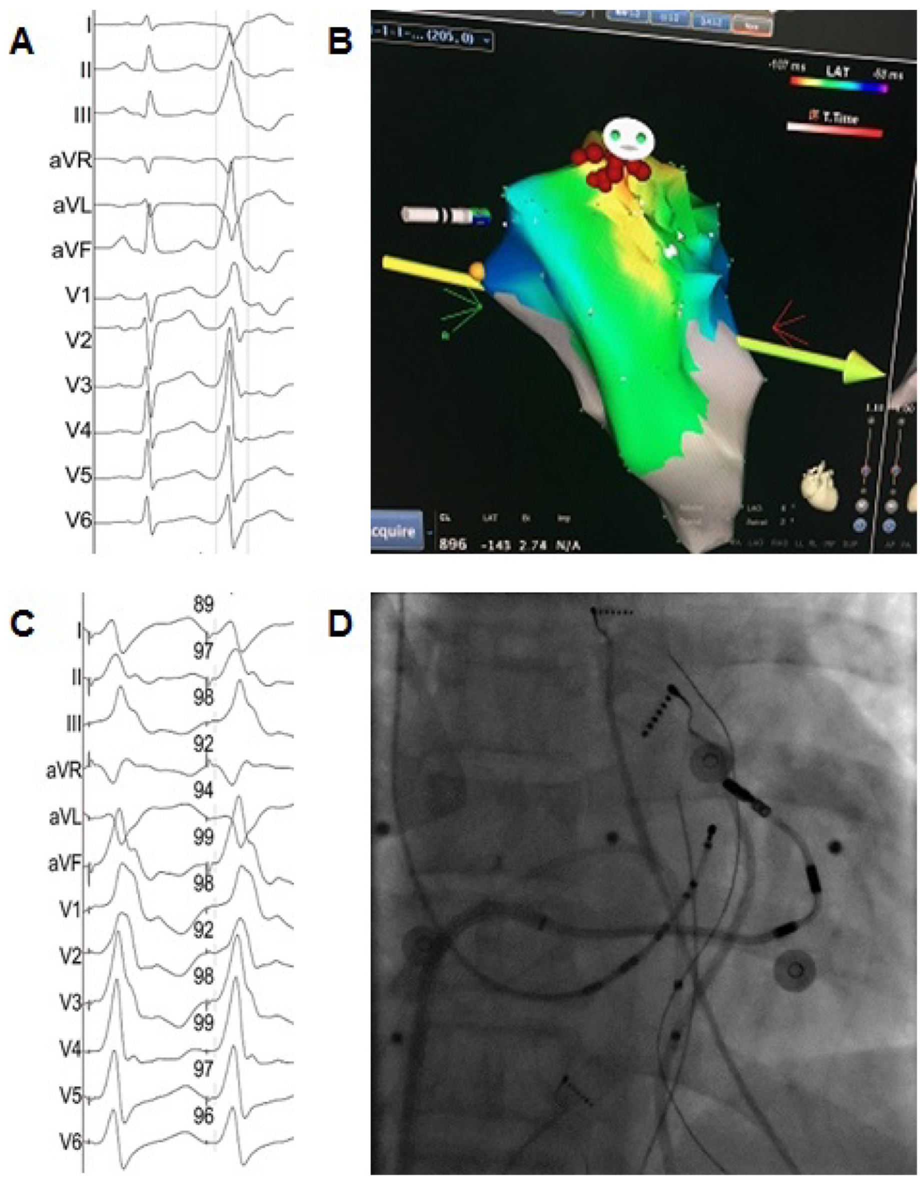

Fig. 1. RMN-guided AMC-VPC ablation Panel A shows the clinical VPC morphology. Panel B, the activation map of VPC, shows that the earliest activation site is localized at AMC. In panel C, pace mapping is performed at the site of earliest ventricular activation, demonstrating according with the QRS morphology compared with the clinical VPC. Panel D shows that RMN manipulates the mapping catheter to form a reverse "S" curve to reach the LVOT via a transseptal approach. The RMN catheter is introduced into the LV cavity using a steerable sheath. The operator can drive the catheter close to inferior wall and then reverse the vector up while slowly moving the catheter forward until it loops. Making a loop provides good stability.