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Electrocardiographic estimation of successful ablation site in patients with manifest inferior paraseptal accessory pathway

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Abstract Inferior paraseptal accessory pathways (APs) have a wide distribution and prediction of AP location before radiofrequency ablation is very important in such pathways. We aimed to estimate successful ablation site based on electrocardiogram in 137 patients (mean age: 25.8 ± 9.0; 126 males) with single manifest inferior paraseptal AP.

Right endocardial inferior paraseptal APs were discriminated from left endocardial APs with an R/S ratio <1 ($p < 0.001$) and negative delta wave in lead V1 ($p < 0.001$). Epicardial inferior paraseptal APs were differentiated from endocardial APs by a negative delta wave in lead II ($p = 0.001$), positive delta waves in AVR ($p < 0.001$) and V1 ($p = 0.012$), R/S ratio <1 in lead II ($p = 0.03$), and R/S ratio ≥1 in V1 ($p = 0.04$).

Delta wave polarity and R/S ratio in lead V1 differentiate right endocardial inferior paraseptal APs from left endocardial APs. Delta wave polarities in leads II, AVR and V1, and R/S ratios in leads II and V1 estimate epicardial inferior paraseptal APs.

Keywords: Inferior paraseptal; Accessory pathway; Radiofrequency ablation

Introduction

Radiofrequency (RF) catheter ablation is an important treatment of choice for patients with Wolf–Parkinson–White syndrome. Prediction of accessory pathway (AP) location before the ablation procedure is important because procedure time may be shortened and radiation exposure may be reduced. Electrocardiographic (ECG) identification of AP location may guide the endocavitary mapping and ablation procedures.

The posteroseptal region is a complex structure, located in the crux of the heart, where the four cardiac chambers meet in the close proximity posteriorly [1,2]. In the living heart, posteroseptal region is positioned inferiorly. Again, there is not an anatomical true septum, except for the membranous septum. For these reasons, it is better to describe posteroseptal accessory pathways (APs) as being 'inferior paraseptal' [3–5]. Such APs constitute about 30% of all APs [6,7]. Inferior paraseptal APs may be located at endocardial site along the tricuspid annulus or the mitral annulus or at epicardial site around the proximal coronary sinus (CS) or the middle cardiac vein. Such wide distribution makes the mapping and RF ablation of such APs difficult.

Several studies revealing localization of inferior paraseptal APs have suggested some ECG criteria based on delta wave and QRS morphologies [8–16]. However, they have concluded some different results and they have small patient numbers with manifest inferior paraseptal AP. We aimed to estimate successful ablation site according to ECG findings in patients with single manifest inferior paraseptal AP over a 100-year period.

Methods

Between 2004 and 2014, 185 consecutive patients with ventricular preexcitation who underwent electrophysiologic study for AP located at the inferior paraseptal region were retrospectively analyzed. Inferior paraseptal APs were defined as pathways located between the CS ostium and the septal attachment of the septal tricuspid leaflet; within 2 cm to the left of the CS ostium at the crux area and over the posteromedial mitral annulus [1,2,5]. Patients with manifest ventricular preexcitation (QRS ≥ 110 ms on the 12-lead ECG) and single AP assessed by electrophysiologic study were included, and patients who had poor ECG quality,

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insufficient preexcitation, or multiple APs were excluded from the study. Thus, 137 patients were included.

Electrocardiographic evaluation

Electrocardiograms were recorded in sinus rhythm immediately before electrophysiologic study. The ECGs were printed at a paper speed of 25 mm/s and amplitude of 10 mm/mV. All ECGs that were included had a clear delta wave and the combination of delta wave and QRS complex width was at least 120 ms. The initial 40 ms of the preexcited QRS complex in each of the frontal leads and the initial 60 ms of the preexcited QRS complex in each of the precordial leads were taken as delta wave [11]. If delta wave was above the baseline without any part below the baseline in a given lead, it was considered as positive for that lead. If delta wave was below the baseline without any part above the baseline, it was considered as negative. The isoelectric delta was considered as the whole delta wave on the baseline. The biphasic delta wave was considered if delta wave was composed of both positive and negative components [11]. Moreover, the morphology of QRS complexes was analyzed in all leads. Two investigators unaware of the data of electrophysiologic studies reviewed all the ECGs. The results were compared with actual locations of APs obtained from mapping and ablation.

Electropysiologic study

Informed written consent was obtained and cardioactive drugs were ceased for at least 5 half-lives before the electrophysiologic study. Three quadripolar catheter with 4-mm interelectrode distance were sent from the femoral vein into the right heart and positioned in the high right atrium, at the His recording site of the tricuspid ring and in the right ventricular apex. A fourth decapolar steerable catheter was introduced through the femoral vein into the CS. Among the patients with a left inferior paraseptal AP, a 7 F introducer was positioned into the femoral artery to go into the left ventricular cavity. Programmed atrial and ventricular stimulations were performed in all patients to determine functional and anatomic properties of APs.

Mapping and ablation

The selection of initial approach was based on the findings of the preceding electrophysiologic mapping. An AP location was identified by antegrade mapping during sinus rhythm or atrial pacing, or retrograde mapping during orthodromic atrioventricular (AV) reentrant tachycardia or ventricular pacing [14]. It was based upon the presence of closely coupled AV activity, if possible along with AP potentials recorded from the distal pole of ablation catheter [15]. If the closest AV relationship was recorded in the inferior paraseptal region of the tricuspid annulus or at the level of the CS ostium, AP location was considered as the right inferior paraseptal and RF delivery to this region was tried first [15]. If the closest AV activity was recorded in a CS catheter dipole to the left of the CS ostium, AP location was considered as the left inferior paraseptal and RF delivery to this region was performed first. A 7 F 4 mm tip quadripolar steerable ablation catheter was sent searching for target site in the left (femoral artery approach) or the right (femoral vein approach). If ablation was unsuccessful by RF delivery to the right or left inferior paraseptal area, the contralateral site was tried. In case of failure at right or left-sided approach, proximal CS and middle cardiac vein were mapped [14]. When successful AP ablation site was ≥ 1 cm within the CS or ≥ 1 cm inside the middle cardiac vein, AP was considered as epicardial [16].

Unfractioned heparin was administered as an intravenous bolus before delivery of the RF current (2500 U to the right posteroseptum, 5000 U to the left posteroseptum). The RF current was performed with the use of a 484 kHz continuous-wave current generator (Atakr II; Medtronic Inc.) between the distal electrode of an ablation catheter and a large cutaneous patch electrode placed over the left scapula. The delivered energy power was set between 30 and 40 W for APs targeted in one of the AV rings and between 15 and 20 W for APs found in the CS wall [12]. Radiofrequency current was continued for at least 10 s before interruption if it was ineffective, or for 90 to 120 s if it was successful. Whenever changes in the catheter tip position or impedance rise were noted, the RF delivery was immediately terminated.

If RF ablation was successful, a control electrophysiological study was performed 30 min after ablation to confirm both antegrade and retrograde block of AP activity and postablation conduction properties of the AV node and His-Purkinje system.

Patients were discharged next day after control ECGs and echocardiograms were obtained. They were followed-up at first month and every 6 months afterwards.

Statistical analysis

The analyses were performed using SPSS software (Statistical Package for the Social Sciences, Version 20.0, SPSS Inc., Chicago, IlL, USA). The distribution of continuous variables for normality was tested with Shapiro–Wilk test and data were presented as mean ± SD for variables with a normal distribution, or median and interquartile ranges for variables with a not normal distribution. Categorical variables were presented as frequencies, and differences between the groups were compared with the Chi-square test. Variables with a normal distribution were compared using independent sample t-test. The groups for nonhomogeneously distributed variables were compared using Mann–Whitney U test. Sensitivity, specificity, positive and negative predictive values were determined using ROC analysis. All P values were two-sided, and a P value of 0.05 or less was considered significant.

Results

The mean age of the patients was 25.8 ± 9.0 and 126 (91.9%) were men. Ninety-eight patients (71.5%) had right endocardial inferior paraseptal APs, 32 (23.3%) had left endocardial inferior paraseptal APs, and 7 (5.1%) had epicardial inferior paraseptal APs. One patient had Ebstein's