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Original article

Characteristics of the conduction of the left atrium in atrial fibrillation using non-contact mapping

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KEYWORDS

Ablation;
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Summary

Background: We evaluated the conduction properties of the posterior left atrium (LA) using a non-contact mapping (NCM) system as well as the significance of linear ablation at the roof of the posterior LA (LA roof) and inferior region of the posterior LA (LA bottom).

Methods and results: In 133 patients with atrial fibrillation (AF) (83 paroxysmal type, 50 persistent/long-lasting persistent type), we performed complete isolation of the posterior LA including pulmonary veins (Box isolation) using NCM. Isochronal activation maps were analyzed during sinus rhythm (SR), during pacing from the proximal coronary sinus (CS), and during pacing within the posterior LA before and after ablation. In sinus rhythm, horizontal conduction along the LA roof line, but not into the posterior LA wall, was observed in 59% of the patients. During paroxysmal CS pacing, horizontal conduction along the LA bottom line was observed in 69% of the patients. Posterior wall pacing conducted vertically over the LA roof and bottom lines in 98% and 83% of the patients, respectively. During AF, rotor wave conduction into the posterior LA through the LA roof and bottom lines was observed in 85% of the patients. Heterogeneous conduction directions in the posterior LA at the LA roof and bottom lines were observed in 60% of the patients.

Abbreviations: AF, atrial fibrillation; AT, atrial tachycardia; LA, left atrium; RA, right atrium; MV, mitral valve; NCM, non-contact mapping; SR, sinus rhythm; HRA, high right atrium; CS, coronary sinus; PVs, pulmonary veins; LSPV, left superior pulmonary vein; LIPV, left inferior pulmonary vein; RSPV, right superior pulmonary vein; RIPV, right inferior pulmonary vein; LAD, left atrial dimension; LVEF, left atrial ejection fraction.

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Conclusions: Heterogeneous conduction was observed at the roof and inferior region of the posterior LA in most of these AF patients. The conduction properties of the posterior LA are affected by the direction of the wavefronts, and this may play an important role in the initiation and maintenance of AF. The complete isolation of the posterior LA may prevent AF.
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Introduction

Atrial fibrillation (AF) is often due to premature beats from pulmonary veins (PVs) [1,2]. The electrical isolation or disconnection of the PVs from the left atrium (LA) can enable the radical cure of AF [3–6]. Although the electrophysiological properties of PVs have been evaluated in previous studies, the characteristics of conduction of the LA body are not well known. A non-contact mapping (NCM) system with a single-beat mapping capacity can facilitate the recognition of propagation patterns and demonstrate the characteristics of the relationship with underlying anatomical structures. Therefore, we conducted this study to evaluate the characteristics of conduction of the LA body using a NCM system as well as the significance of linear ablation of the LA roof and bottom.

Methods

Study population

A total of 133 consecutive patients (103 men and 30 women; mean age 58 ± 11 years) with symptomatic drug-refractory AF were enrolled from October 2006 to March 2008 in this retrospective study. All patients gave their written informed consent.

Electrophysiological study

Patients received oral anticoagulants for at least 1 month before ablation. Trans-esophageal echocardiography was performed to exclude any LA thrombi before ablation. Antiarrhythmic drugs were discontinued five half-lives before ablation. Three 5-French quadripolar electrode catheters (St Jude Medical, Minnetonka, MN, USA) were placed in the high right atrium, His bundle area, and coronary sinus (CS). Triple transseptal punctures were performed, and two 8-French SLO sheaths (St Jude Medical) and a 10-French SLO sheath (St Jude Medical) were advanced into the LA. After transseptal puncture, 100 IU heparin/kg was given intravenously. During the procedure, heparinization was continued to maintain an activated clotting time of >300 s. PV angiography was performed from a sheath to determine the size and shape of the PVs. Surface electrocardiograms (ECG) and bipolar endocardial electrograms were continuously monitored and stored on a computer-based digital amplifier/recorder system for offline analysis (Lab-System™ PRO, Bard Electrophysiology, Lowell, MA, USA). Intra-cardiac electrograms were filtered from 30 to 500 Hz and measured at a sweep rate of 200 or 400 mm/s. Atrial pacing was performed using a programmed stimulator (SEC-3102, Nihon Kohden, Tokyo, Japan).

Non-contact mapping

A multi-electrode array catheter (EnSite 3000; St Jude Medical) was inserted into the LA via the 10-French SLO sheath and the tip of the array was positioned in the LA appendage. A decapolar ring catheter (Lasso, Biosense-Webster, Diamond Bar, CA, USA) was inserted into the LA and used for the mapping of PVs. A deflectable, quadripolar 7-Fr ablation catheter (Ablaze Fantasia, Japan Lifeline Co., Ltd., Tokyo, Japan) was also inserted into the LA for mapping and ablation. The NCM technique has been described elsewhere [7–11]. A three-dimensional geometry was created by maneuvering the Lasso and ablation catheters in the LA and PVs under fluoroscopic guidance and angiography (Fig. 1A and B). In patients who had been in sinus rhythm (SR) at the beginning of the study, derived isopotential and isochronal activation maps were analyzed during SR, during pacing from the proximal CS, and during pacing from five sites within the posterior LA (left superior, left inferior, center, right superior, and right inferior). Burst pacing was then performed in an attempt to induce sustained AF prior to proceeding with ablation and confirmed isochronal activation maps during AF.

Measurements and definitions

P-wave duration was the time interval from P-wave onset to the end of LA activation. The P-wave signals (>5 min) were recorded from body surface ECG (II) before and after Box isolation. The signals from lead II were filtered bidirectionally through a filter setting 50–150 Hz. To identify the earliest activation point in LA breakout side was defined as a single white spot of isopotential map that can be confirmed visible and indicates QS morphology of NCM virtual unipolar electrograms. The end of LA activation was disappearance of isopotential map and virtual unipolar electrograms amplitude completely return to the baseline. During review of the recorded data was analysis with a default band-pass filter setting of 2–300 Hz. The averaged diastolic pacing threshold of the posterior wall was 2.5 V and all posterior wall pacing during conduction mapping was performed at 5.0 V. Proximal CS pacing was performed at a fixed rate of 100 bpm (600 ms).

Catheter ablation

Ablation was performed with a temperature-controlled, dumbbell-shaped 8-mm-tip ablation catheter (Ablaze Fantasia, Japan Lifeline Co., Ltd., Tokyo, Japan). In 109 patients (82%) with spontaneous or induced sustained AF and persistent/long-lasting persistent AF, ablation was performed in either induced sustained or persistent/long-lasting persistent AF. In the other 24 patients (18%), ablation

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