Journal of Arrhythmia ■ (■■■■) ■■■–■■■

Contents lists available at ScienceDirect

Journal of Arrhythmia

journal homepage: www.elsevier.com/locate/joa

Original Article

Left atrial remodeling: Regional differences between paroxysmal and persistent atrial fibrillation

Rikitake Kogawa, MD[a], Yasuo Okumura, MD[a,*], Ichiro Watanabe, MD[a], Koichi Nagashima, MD[a], Keiko Takahashi, MD[a], Kazuki Iso, MD[a], Ryuta Watanabe, MD[a], Masaru Arai, MD[a], Sayaka Kurokawa, MD[a], Kimie Ohkubo, MD[a], Toshiko Nakai, MD[a], Atsushi Hirayama, MD[a], Kazumasa Sonoda, MD[b], Toshimasa Tosaka, MD[b]

[a] Division of Cardiology, Department of Medicine, Nihon University School of Medicine, 30-1, Oyaguchi-kamimachi, itabashi-ku, Tokyo 173-8610, Japan
[b] Division of Cardiology, Department of Medicine, Tokyo Rinkai Hospital, 1-4-2, Rinkai cho, Edogawa-ku, Tokyo 134-0085, Japan

ARTICLE INFO

Article history:
Received 29 March 2017
Received in revised form
30 May 2017
Accepted 8 June 2017

Keywords:
Atrial fibrillation
Structural remodeling
Left atrial voltage
Electroanatomic mapping

ABSTRACT

Background: The mechanisms underlying self-perpetuation of persistent atrial fibrillation (AF) are not well understood. To gain insight into these mechanisms, we conducted a study comparing left atrial (LA) electroanatomic maps obtained during sinus rhythm between patients with paroxysmal AF (PAF) and patients with persistent AF (PerAF).
Methods: The study included 23 men with PAF (age, 56.3 ± 12.1 years) and 13 men with PerAF (age, 54.3 ± 13.4 years). LA voltage mapping was performed during sinus rhythm. The clinical and electroanatomic characteristics of the two groups were evaluated and analyzed statistically.
Results: The bipolar voltages at the LA septum, roof, and posterior wall, right superior pulmonary vein (PV) and its antrum, right superior PV carina, and right inferior PV antrum were significantly lower in patients with PerAF than in those with PAF. The bipolar voltages in other parts of the LA did not differ statistically between the two groups.
Conclusion: PAF and PerAF seem to be characterized by differences in the regional voltage in the LA and PVs. The LA structural remodeling of PerAF may initiate from the right PVs and their antra and LA septum, roof, and posterior wall.

1. Introduction

It is widely accepted that atrial fibrillation (AF) arises as a result of a complex interaction among the initial trigger, substrate, and perpetuators [1]. It has been shown experimentally that the shortened effective refractory period (ERP) and slowed conduction that result from AF promote continuance of the AF, leading to the concept that "AF begets AF" [2]. Indeed, this paradigm appears to be relevant in both paroxysmal AF (PAF) and persistent AF (PerAF) [1]. Although experimentally induced sustained AF has been shown to lead mainly to structural changes in the atrial myocytes [3], the atrial substrate in patients with PAF and in those with PerAF has not been well characterized. Prior studies have shown that the left atrial (LA) voltage was lower in patients with PerAF than in those with PAF [4–6]; however, the regional distribution of LA voltage has not been fully evaluated in either patients with PAF or PerAF. Thus, we conducted a study to compare the regional differences in the LA voltage between patients with PAF and PerAF.

2. Material and methods

2.1. Study patients

The study included 23 and 13 patients undergoing radiofrequency ablation for PAF and PerAF, respectively. All patients were men aged 55.6 ± 12.4 years. Patients with structural heart disease or valvular heart disease were not included in the study so that the potential influence of these diseases on atrial remodeling would be avoided. Patients who had undergone a prior AF ablation procedure were also excluded from the study. In addition, patients with left ventricular (LV) dysfunction (LV ejection fraction [EF] < 50%), coronary artery disease, severe obstructive apnea, or poorly controlled hypertension associated with a significant echocardiographically determined LV hypertrophy (myocardial

Abbreviations: PAF, paroxysmal atrial fibrillation; PerAF, persistent atrial fibrillation; LA, left atrium; PV, pulmonary vein; ERP, effective refractory period.

* Corresponding author. Fax: +81 3 3972 1098.
E-mail address: yasuwo128@yahoo.co.jp (Y. Okumura).

http://dx.doi.org/10.1016/j.joa.2017.06.001

wall thickness >1.1 cm) were excluded. AF was defined as paroxysmal when episodes lasted <7 days and self-terminated and as persistent when episodes lasted >7 days [7]. The study protocol was approved by the Human Research Ethics Committee of Nihon University Itabashi Hospital (May 25, 2016; RK-160614-10), and all patients provided written informed consent for their inclusion in the study.

2.2. Electrophysiological study

All study patients were maintained on anticoagulation therapy for at least 1 month before the ablation procedure, with a target international normalized ratio of 2.0–3.0 for those who were administered warfarin. Antiarrhythmic medications were stopped for at least 5 half-lives before the procedure. All patients underwent transesophageal echocardiography 1 day before the procedure to rule out the possibility of LA thrombus. Electrophysiological study and ablation were performed under conscious sedation achieved with propofol and fentanyl. The surface electrocardiogram and endocardial electrogram findings were monitored and stored in a digital electrophysiology recording system (BARD LabSystem Pro, Murray Hill, NJ, USA). The intracardiac electrograms were filtered at 30–250 Hz and measured at a sweep speed of 100–200 mm/s. The LA was accessed via a transseptal puncture, and a heparin bolus was administered to achieve a target activated clotting time (ACT) of >300 s.

2.3. Electroanatomic mapping

The electrophysiological study was performed in all patients under conscious sedation achieved with dexmedetomidine, propofol, and fentanyl. After obtaining vascular access, a single transseptal puncture was created, and intravenous heparin was administered to maintain an ACT of >300 s. After inserting two long sheaths (1 SL0 sheath and 1 Agilis sheath; St. Jude Medical, Inc., St. Paul, MN, USA) into the left atrium via the transseptal puncture, the three-dimensional (3D) geometry of the left atrium and the pulmonary veins (PVs) was reconstructed with the use of an EnSite NavX Classic system (St. Jude Medical, Inc.) and a 20-pole circular mapping catheter with 4-4-4-mm interelectrode spacing (AFocus II catheter, St. Jude Medical, Inc.). We recorded multiple bipolar signals from adjacent electrode pairs (1–2, 2–3, 19–20; filter setting: 30–300 Hz) simultaneously during sinus rhythm (SR). If the patients had AF, SR electrograms were recorded after cardioversion. A bipolar electrogram amplitude of <0.5 mV was identified as a low voltage, and that of ≥ 1.5 mV was identified as a normal voltage. More than 400 location points per patient and at least >30 points per segment were recorded for each patient.

2.4. LA/PV segmentation

The left atrium and PVs were divided into 16 segments: LA anterior wall, LA septum, LA floor, LA posterior wall, LA roof, and LA appendage; right superior PV (RSPV), RSPV antrum, right PV (RPV) carina, right inferior PV (RIPV), and RIPV antrum; and left superior PV (LSPV), LSPV antrum, left PV (LPV) carina, left inferior PV (LIPV), and LIPV antrum (Fig. 1). The PV antrum was defined as the area where a unique potential with double deflections (LA and PV potentials) could be documented between the PV ostium and LA body. The PV ostium was identified as the point of maximal inflection between the PV wall and LA wall. The carina was defined as the area between the superior PV antrum and inferior PV antrum.

For each of the 16 segments, bipolar electrogram amplitudes were compared between patients with PAF and those with PerAF. The mean bipolar voltage was calculated for each segment.

2.5. Statistical analysis

The study variables were presented as mean $\pm$ SD values or numbers and percentages of the patients. Between-group differences in the continuous variables were analyzed using the Mann-Whitney U test. All statistical analyses were performed using the StatView 5.0 software (SAS Institute, Cary, NC, USA), and $p<0.05$ was considered significant.

3. Results

3.1. Patients' clinical characteristics

The patients' clinical characteristics and indices of cardiac function are summarized in Table 1. There was no significant difference in age or sex ratio between the PAF group and PerAF group. AF duration was significantly longer in the PerAF group than in the PAF group. A history of heart failure ($\geq$ NYHA Class III) was significantly more prevalent in the PerAF group than in the PAF group. LA diameter, LA volume, and LV end-systolic and end-diastolic dimensions were significantly greater in the PerAF group than in the PAF group. The LVEF did not differ significantly between the two groups.

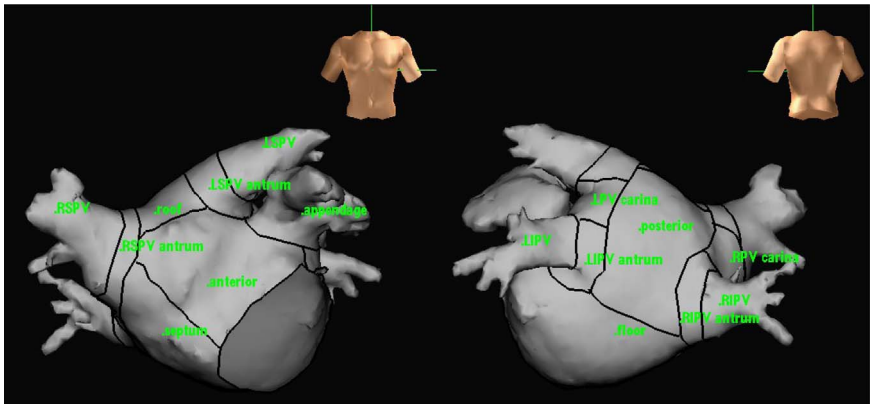

Fig. 1. Anatomical regions of the left atrium (LA) and pulmonary veins (PVs). LA body: roof, anterior wall, posterior wall, interatrial septum, and floor; Right PVs: right superior (RS) PV, RSPV antrum, right (R) PV carina, right inferior (RI) PV, and RIPV antrum; left PVs: left superior (LS) PV, LSPV antrum, left (L) PV carina, LIPV, and LIPV antrum; and LA appendage.

Please cite this article as: Kogawa R, et al. Left atrial remodeling: Regional differences between paroxysmal and persistent atrial fibrillation. J Arrhythmia (2017), http://dx.doi.org/10.1016/j.joa.2017.06.001