Comparison of Pulmonary Venous and Left Atrial Remodeling in Patients With Atrial Fibrillation With Hypertrophic Cardiomyopathy Versus With Hypertensive Heart Disease

Kentaro Yoshida, MD[a,b,*], Hideyuki Hasebe, MD[c], Yasuaki Tsumagari, MD[b], Hidekazu Tsuneoka, MD[b], Mari Ebine[b], Yoshiko Uehara, BSN[b], Yoshihiro Seo, MD[a], Kazutaka Aonuma, MD[a], and Noriyuki Takeyasu, MD[b]

Left ventricular diastolic dysfunction in hypertrophic cardiomyopathy (HC) increases susceptibility to atrial fibrillation. Although phenotypical characteristics of the hypertrophied left ventricle are clear, left atrial (LA) and pulmonary venous (PV) remodeling has rarely been investigated. This study aimed to identify differences in LA and PV remodeling between HC and hypertensive heart disease (HHD) using 3-dimensional computed tomography. Included were 33 consecutive patients with HC, 25 with HHD, and 29 without any co-morbidities who were referred for catheter ablation of atrial fibrillation. Pre-ablation plasma atrial and brain natriuretic peptide levels, post-ablation troponin T level, and LA pressure were measured, and LA and PV diameters were determined 3 dimensionally. LA transverse diameter in the control group was smaller than that in the HHD or HC group (55 ± 6 vs 63 ± 9 vs 65 ± 12 mm, p = 0.0003). PV diameter in all 4 PVs was greatest in the HC group and second greatest in the HHD group (21.0 ± 3.1 vs 23.8 ± 2.8 vs 26.8 ± 4.1 mm, p <0.0001 for left superior PV). Differences in PV size between the HHD and HC groups were enhanced by indexing to the body surface area (12.4 ± 1.9 vs 13.1 ± 1.4 vs 16.1 ± 3.3 mm/m^2, p <0.0001). The PV/LA diameter ratio was greater in the HC than in the other groups (0.38 ± 0.06 vs 0.38 ± 0.05 vs 0.42 ± 0.07, p = 0.01). Atrial natriuretic peptide, brain natriuretic peptide, troponin T levels, and LA pressure were highest in the HC group (all p <0.05). In conclusion, the stiff LA caused from atrial hypertrophy may account for higher levels of biomarkers, higher LA pressure, and PV-dominant remodeling in HC. **(Am J Cardiol 2017;119:1262−1268)**

Hypertrophic cardiomyopathy (HC), a familial myocardial condition caused by sarcomere protein mutations, is usually recognized by early adulthood. Phenotypically, it is characterized by asymmetric hypertrophy and associated diastolic dysfunction of the left ventricle (LV).[1,2] Resultant pressure overload stretches the left atrium (LA) and increases susceptibility to atrial fibrillation (AF).[3,4] Anatomical characteristics of the LV are well known and are used to categorize the disease and stratify the risk of sudden death. Although the myopathic process may also affect the atrial myocardium,[2,5−7] atrial and pulmonary venous (PV) anatomy associated with the co-morbidity of AF has rarely been investigated. This study aimed to identify differences in LA and PV remodeling between HC and hypertensive heart disease (HHD) using 3-dimensional computed tomography (CT) of the heart. Because LV hypertrophy in HHD is a secondary response of the cardiomyocytes to the pressure overload caused by systemic hypertension, the features of LA and PV remodeling might be different between the 2 diseases.

Methods

The study subjects comprised 33 consecutive patients with HC and 25 consecutive patients with HHD who were referred for initial catheter ablation of AF at our institution from April 2012 to March 2015. Twenty-nine consecutive patients who did not have any previous illnesses including systemic hypertension and underwent catheter ablation of lone AF from April 2014 to March 2015 served as the control group. The study protocol was approved by the local institutional review board, and all patients provided their written informed consent.

The diagnosis of HC was determined by marked LV thickness, a pattern of LV hypertrophy, LV outflow tract obstruction with systolic anterior motion, and a family history of HC.[1] The diagnosis of HHD was defined as having hypertension requiring multiple antihypertensive drugs and an LV wall thickness of ≥12 mm. Patients who had previous LA ablation, other structural heart diseases, such as

[a]Cardiovascular Division, Faculty of Medicine, University of Tsukuba, Tsukuba, Japan; [b]Division of Cardiovascular Medicine, Ibaraki Prefectural Central Hospital, Kasama, Japan; and [c]Division of Arrhythmology, Shizuoka Saiseikai General Hospital, Shizuoka, Japan. Manuscript received October 27, 2016; revised manuscript received and accepted December 22, 2016.

See page 1267 for disclosure information.

*Corresponding author: Tel: +81 (29) 853-3142; fax: +81 (29) 853-3143.

E-mail address: kentaroyo@nifty.com (K. Yoshida).

0002-9149/17/$ - see front matter
http://dx.doi.org/10.1016/j.amjcard.2016.12.025

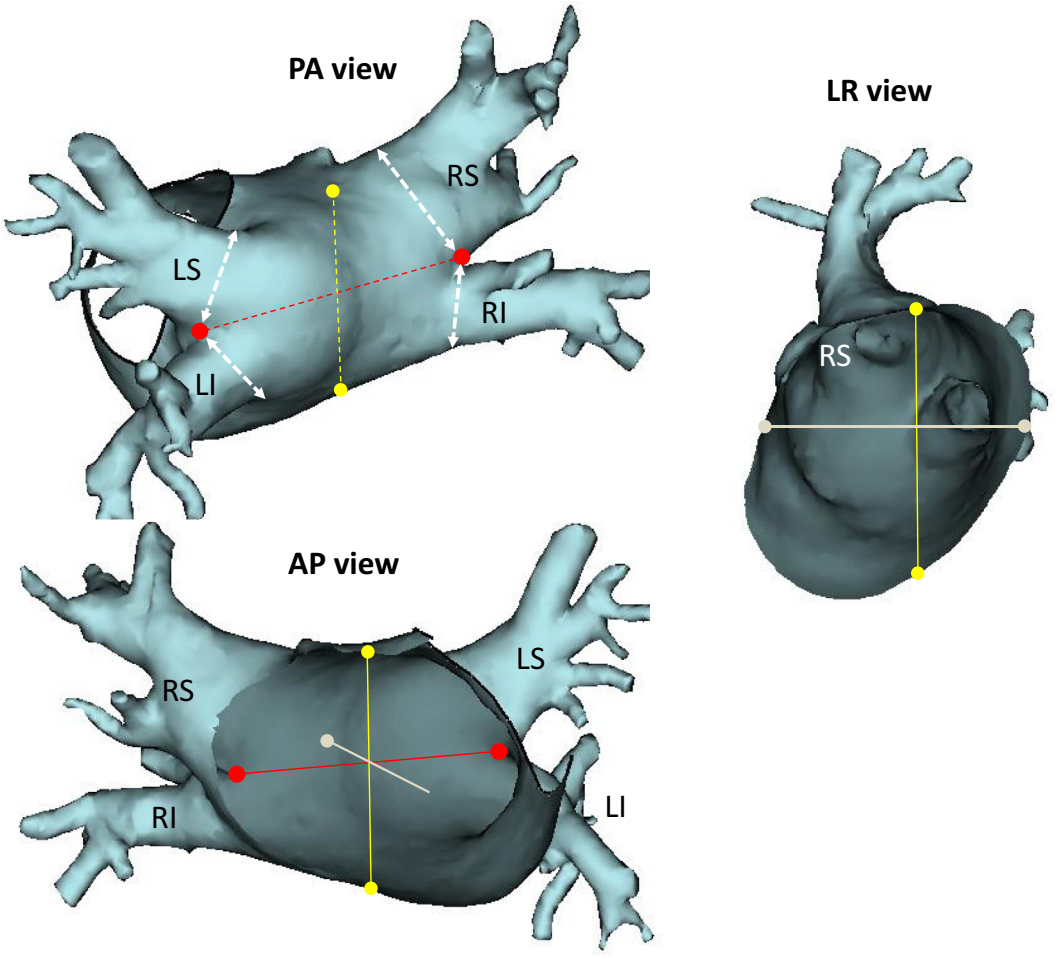

Figure 1. Definitions of the LA and PV diameters on computed tomography imaging. *Red*, *yellow*, and *gray lines* indicate transverse, anteroposterior, and longitudinal diameters, respectively, and the *white line* indicates PV longitudinal diameter. AP = anteroposterior; LA = left atrial; LI = left inferior; LS = left superior; PV = pulmonary vein; RI = right inferior; RS = right superior.

moderate-to-severe mitral regurgitation and ischemic heart disease, severely decreased renal function (estimated glomerular filtration rate <30 ml/min/1.73 m^2), or left common PV were excluded from the study.

Levels of atrial and brain natriuretic peptides (ANP and BNP, respectively) were measured 1 day before ablation, and the level of troponin T (TnT) was measured 1 day after ablation.[8,9] An ECG-gated 256-slice CT of the heart was performed within 7 days before the ablation procedure (SOMATOM Definition Flash; Siemens, Erlangen, Germany). The LA and PVs were reconstructed with 3-dimensional segmentation software using a CARTO 3 System (Biosense Webster, Diamond Bar, California). LA and PV anatomy in all patients was assessed by the same reviewer who was blinded to the patients' history of cardiovascular disease.[10–12] Twenty patients were selected at random for the assessments of the intraobserver and interobserver reproducibilities of the LA and PV measurements.

1. The transverse diameter of the LA was defined as the distance between the midpoints of the right and left sides of the PVs (so-called carina) (Figure 1). These points at the carina were considered as base points for all the following measurements.[13]
2. The anteroposterior dimension of the LA was measured at the midpoint of the transverse diameter (Figure 1).
3. The longitudinal diameter of the LA was measured at the midpoint of the transverse diameter (diameter between the roof and the bottom of the LA, Figure 1).
4. The LA volume was calculated using the biplane dimension-length formula, as described previously.[10]
5. The longitudinal (superoinferior) diameter of each PV ostium was measured (Figure 1). The venoatrial junction was determined on the epicardial aspect at the inflection point where the PV inserted into the atrium.[12] The longitudinal diameter of the PV was defined as the diameter between the venoatrial junction and the base point at the carina on each side.

Throughout the ablation procedure, a 6Fr 20-pole dual-site mapping catheter (BeeAT; Japan Lifeline Co. Ltd, Tokyo, Japan) was positioned in the coronary sinus and the lateral wall of the right atrium. Two long sheaths (SL0; AF Division, St. Jude Medical, Minnetonka, Minnesota) were advanced into the LA. LA pressure was defined as the height of "v" wave (mm Hg) and measured just after transeptal puncture using a long sheath connected to a pressure