Quantitative Analysis of Quantity and Distribution of Epicardial Adipose Tissue Surrounding the Left Atrium in Patients With Atrial Fibrillation and Effect of Recurrence After Ablation

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Epicardial adipose tissue (EAT) contains ganglionated plexuses and adipocytes that can affect the pathogenesis of atrial fibrillation (AF). The aim of this study was to quantify the EAT surrounding the left atrium (LA) and correlate it with occurrence of AF and outcome after catheter ablation. EAT was evaluated using 64-slice multidetector computed tomography in 68 patients with AF and 34 controls. EAT volume was acquired by semiautomatically tracing axial images from the pulmonary artery to the coronary sinus. Topographic distribution of EAT was assessed by dividing the periatrial space into 8 equal regions. EAT volume significantly increased in patients with AF than in controls (29.9 ± 12.1 vs 20.2 ± 6.5 cm^3, $p < 0.001$). Most EAT was located in regions (1) within the superior vena cava, right pulmonary artery, and right-sided roof of the LA (29.8%), (2) within the aortic root, pulmonary trunk, and left atrial appendage (26.5%), and (3) between the left inferior pulmonary vein and left atrioventricular groove (18.1%). Baseline variables were analyzed in patients with (n = 24) and without (n = 44) AF recurrence after ablation. The recurrent group showed significantly increased EAT (35.2 ± 12.5 vs 26.8 ± 11.1 cm^3, $p = 0.007$). Multivariate analysis revealed that EAT was an independent predictor of AF recurrence after ablation ($p = 0.038$). In conclusion, EAT of LA was increased in patients with AF. Large clusters of EAT were observed adjacent to the anterior roof, left atrial appendage, and lateral mitral isthmus. Abundance of EAT was independently related to AF recurrence after ablation. **(Am J Cardiol 2011;107: 1498–1503)**

Several studies have shown that epicardial adipose tissue (EAT) is not an anatomic depot of fat but may secrete proinflammatory hormones and cytokines related to coronary artery disease (CAD) and arrhythmias.[1–4] Furthermore, the clinical significance of EAT in patients with metabolic syndrome, diabetes mellitus, and CAD has been well established.[5–9] Recently, 2 reports have described that pericardial fat volume of the entire heart is significantly increased in patients with atrial fibrillation (AF) using multidetector computed tomography.[10,11] However, information focusing on topographic distribution of EAT surrounding the left atrium (LA) and influence of catheter ablation on outcome is still limited. Therefore, the aim of this study was to delineate EAT adjacent to the LA and evaluate its impact on clinical outcome in patients undergoing catheter ablation of AF.

Methods

Sixty-eight consecutive patients with AF (43 with paroxysmal AF and 25 with persistent AF) who underwent radiofrequency ablation of the LA and in whom 64-slice multidetector computed tomography was performed before ablation were included. This group was compared to 34 age- and gender-matched controls who underwent multidetector computed tomography for screening of CAD and had no history of AF. This study was approved by the clinical ethics committee.

Details of the computed tomographic protocols have been described previously.[12,13] Briefly, the LA and pulmonary veins (PVs) were evaluated with an electrocardiographically gated, 64-slice multidetector computed tomographic scanner (Aquilion 64 CFX, Toshiba Medical System, Tokyo, Japan). All participants underwent contrast-enhanced computed tomographic scanning during sinus rhythm. Patients were instructed to hold their breath to acquire the images, which covered an area from the superior margin of the pulmonary hilum to the cardiac apex (collimation 64 × 0.5 mm, gantry rotation time 350 ms, table

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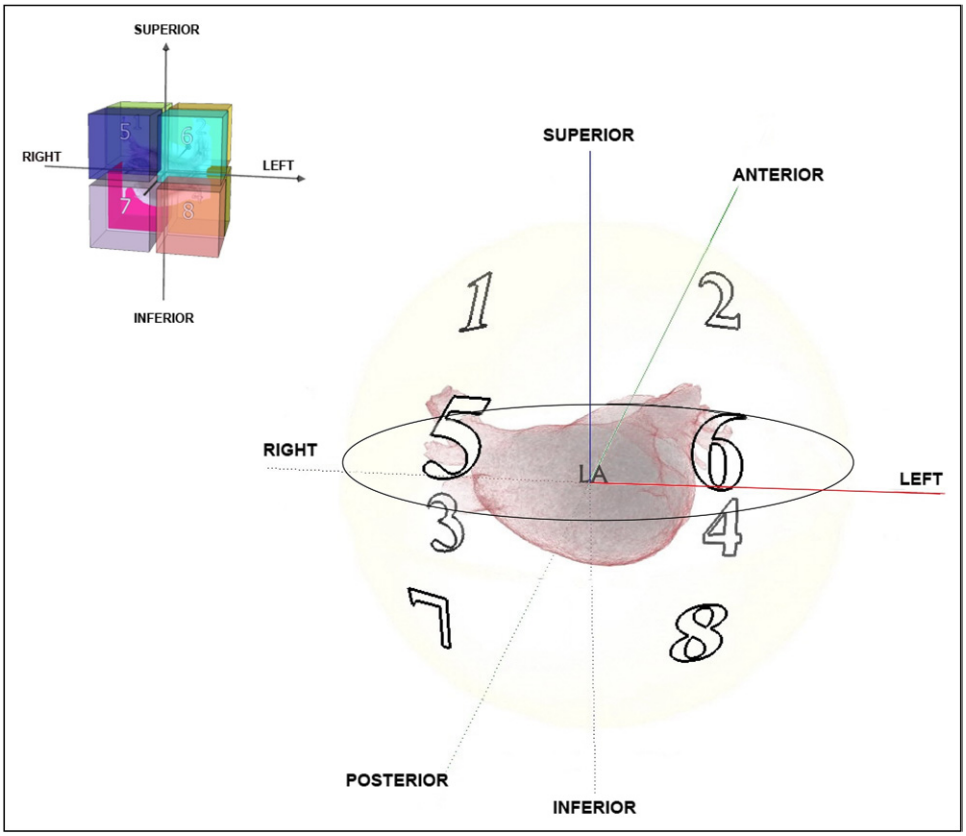

Figure 1. Schematic illustration of 8 regions surrounding the left atrium that was used in the study to quantify epicardial adipose tissue.

speed 6.3 mm/rotation, tube voltage 120 kV, effective tube current 545 mA). Acquisition time was 8 to 12 seconds depending on heart rate.

All computed tomographic images were analyzed offline with software developed by the Department of Biomedical Engineering, Chung Yuan Christian University (Chung-Li, Taiwan).[14] Volume of EAT was obtained using a semiautomated method and fat was recognized using threshold attenuation values of −50 to −200 HU. Axial images at atrial end-diastole were used to trace EAT from the pulmonary artery to the coronary sinus. Total number of slices traced manually was 60 to 112 depending on atrial size. All slices were verified for accuracy by 2 investigators. To understand the topographic distribution of EAT the periatrial space was equally divided into 8 regions. That is, the periatrial space was divided equally into halves in the x, y, and z planes (Figure 1). Region 1 indicates the space of the right anterior-superior LA, region 2 the space of the left anterior-superior LA, region 3 the space of the right anterior-inferior LA, region 4 the space of the left anterior-inferior LA, region 5 the space of the right posterior-superior LA, region 6 the space of the left posterior-superior LA, region 7 the space of the right posterior-inferior LA, and region 8 the space of the left posterior-inferior LA.

Furthermore, 2 phases of multidetector computed tomographic images were obtained for functional assessment of the LA and PVs. Phase 1 was end-systole of the atrium and indicated minimal volume of LA. Phase 2 was end-diastole of the atrium and indicated maximal volume of LA. Maximal and minimal volumes of the LA and left atrial appendage were acquired for analysis. Ejection fractions of the LA and left atrial appendage were defined as (maximal volume minus minimal volume)/maximal volume.

Table 1
Baseline characteristics in patients with atrial fibrillation and those with normal sinus rhythm

Variable	AF (n = 68)	Normal (n = 34)	p Value
Age (years)	54.7 ± 8.5	54.1 ± 9.0	0.74
Men	52 (76%)	21 (62%)	0.35
Body mass index (kg/m^2)	25.6 ± 3.3	26.0 ± 2.7	0.73
Diabetes	7 (10%)	4 (12%)	0.98
Coronary artery disease	5 (7%)	4 (12%)	0.94
Hypertension	10 (15%)	9 (26%)	0.76
Total cholesterol (mg/dl)	193.3 ± 32.6	196.6 ± 21.9	0.20
Triglyceride (mg/dl)	158.7 ± 53.7	162.1 ± 67.3	0.97
Left atrial volume (cm^3)	126.7 ± 45.0	97.4 ± 19.7	0.001
Epicardial adipose tissue (cm^3)			
Total	29.9 ± 12.1	20.2 ± 6.5	<0.001
Region			
1	8.92 ± 3.58	5.35 ± 2.15	<0.001
2	7.93 ± 4.42	5.77 ± 2.97	0.011
3	0.58 ± 0.67	0.42 ± 0.55	0.29
4	0.51 ± 0.76	0.19 ± 0.47	0.027
5	1.94 ± 1.79	0.74 ± 0.60	<0.001
6	2.48 ± 1.93	2.33 ± 1.66	0.85
7	2.12 ± 1.10	2.05 ± 1.09	0.64
8	5.41 ± 3.16	3.34 ± 1.79	0.001