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ORIGINAL ARTICLE

The relation between total epicardial fat volume assessed by cardiac CT and the presence of atrial fibrillation

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KEYWORDS

Atrial fibrillation;
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Abstract *Background:* Obesity is an important risk factor for atrial fibrillation (AF). Local epicardial fat enclosed by the visceral pericardial sac has been hypothesized to exert local pathogenic effects on cardiac structures. We aimed to characterize the relationship between total epicardial fat volume assessed by noncontrast cardiac CT and AF.

Methods: This case control study conducted from May 2013 to December 2014 in cardiology and radiology departments of Benha University Hospitals. Fifty patients with a history of AF were taken up plus control group of 50 reference patients without history of AF. All patients underwent cardiac CT imaging to measure total epicardial fat volume (EFV), together with systemic obesity indices as body mass index (BMI), waist circumference and body weight plus echocardiographic parameters as left atrium (LA) volume index, left ventricular ejection fraction. All these were examined in relation to the presence and chronicity of AF.

Results: EFV was significantly associated with the presence of AF (p values < 0.05). Significant positive correlation between EFV and AF chronicity was denoted. Patients with persistent AF had significantly larger EFV versus patients with paroxysmal AF (p value $= 0.002$). EFV was positively correlated with LA volume index ($r = +0.45$, $p < 0.001$). Multivariate logistic regression model for AF risk factors revealed that EFV was the strongest independent risk factor for AF with highest odds ratio (2.13, 95% CI: 1.01–3.06) followed by odds ratio (1.81, 1.55 and 0.8) for LA volume index, waist circumference and BMI respectively.

Conclusion: Epicardial fat is associated with the presence of AF and predicts chronicity. These associations are independent to systemic measures of adiposity and sensitive echocardiographic parameters as LA volume index. These findings are consistent with the hypothesis of a local pathogenic effect of epicardial fat on the arrhythmogenic substrate supporting AF.

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1. Introduction

Atrial fibrillation (AF) is the most common arrhythmia found in clinical practice.[1] It also accounts for 1/3 of hospital admissions for cardiac rhythm disturbances.[2] Systemic obesity is a common modifiable risk factor for different cardiovascular disorders including AF. Above and beyond hazardous effect of obesity, Epicardial fat defined as the local visceral fat depot enclosed by the visceral pericardial sac shares the same blood supply as adjacent myocardium and also shows paracrine functions. This is the risky fat that is metabolically active and has been hypothesized to exert a local pathogenic inflammatory effect on nearby cardiac structures.[3] In recent years, several studies have shown that an increased epicardial fat volume noninvasively measured by CT or MRI images was strongly associated with the presence of coronary artery disease and atrial fibrillation, and adverse cardiovascular events.[4] Because multiple factors are related to epicardial fat, we hypothesized whether epicardial fat could be independently associated with AF after adjusting multiple factors potentially related to epicardial fat. Therefore, this study was conducted to assess the relationship between epicardial fat volume and the presence and progression of AF when considering covariables related to epicardial fat.

2. Materials and methods

2.1. Study population

This study was a case control study conducted from May 2013 to December 2014 in cardiology and radiology departments in Benha University Hospitals. One hundred patients were selected from cardiology department in Benha University Hospital. Their age ranged from 45 to 65 years and their body mass index (BMI) ranged from 25 to 32. They were divided into two groups as follows: AF group included 50 patients with a documented history of AF. Control group included 50 patients with intermediate risk and had no history of AF. They had age and sex matching to AF group.

All patients in both groups were referred for non-contrast CT for the evaluation of the volume of the total epicardial fat (EFV). This study was approved by the ethical committee in the faculty of medicine, Benha University.

2.2. Methods

All patients were subjected to the following:

2.2.1. History taking

Age, sex, smoking, hypertension, diabetes mellitus, thyrotoxicosis and documented history of AF.

2.2.2. Anthropometric measurements

Weight in kilograms, height in meters, waist circumference and body mass index (BMI) ranged from 25 to 32.

2.2.3. Clinical examination

Full general and local cardiac examination.

2.2.4. Echocardiography

Transthoracic echocardiography was performed with a commercially available system (Vivid Seven, General Electric, Milwaukee, WI). Left atrial volume was calculated using the modified biplane Simpson's method from the apical 2-chamber and 4-chamber views. (Fig. 1) LA volume index was calculated from LA volume (ml)/BSA (m^2). Left atrial enlargement was defined as LA volume index $>22 + -6$ (ml/m^2) for both men and women. Left ventricular ejection fraction (LVEF) was measured using the Simpson method. An LVEF < 50% was considered abnormal. Structural heart disease was defined as moderate or greater amount of valvular regurgitation or left ventricular hypertrophy.[5]

2.2.5. Noncontrast CT

2.2.5.1. Imaging technique. All CT scans were performed in CT unit in Benha University Hospital with The Activion 16 multislice CT scanner, Toshiba Medical Systems. The computer software (Quantum De-noising for Activion 16) was used. All images were interpreted by a single radiologist who had more than 15 years of experience in the interpretation of CT scanning field and he was blinded to the history of AF. Tomogram was taken from tracheal bifurcation to the diaphragm in a single breath-hold in the cranio-caudal direction. The superior heart limit slice is typically chosen at the split of the pulmonary artery. The anatomic landmark for the inferior limit of the heart is typically the most inferior slice of the myocardium or the most inferior slice with the posterior descending artery.[6] Image reconstruction was performed using retrospective ECG-gated acquisition spiral mode. Since epicardial fat is a compressible structure, end systolic frames are used to avoid suspected attenuation of fat during diastole by myocardial mass. A 3-D workstation was used to reconstruct axial images retrospectively at an optimal window. The image data sets were analyzed by means of multiplanar reformatted images (vertical, long-axis, and short-axis views).[6]

2.2.5.2. Measurement of epicardial fat volume (EFV). Using the 3.0-mm-thick axial slices the parietal pericardium was manually traced in every fourth slice starting from the bifurcation of pulmonary artery to the diaphragm. The computer software (Activion 16) then automatically interpolated and traced the parietal pericardium in all slices interposed between the manually traced slices to measure the EFV in cm^3. The total number of slices was 30–40 per heart. All automatically traced slices were examined and verified for accuracy. To ensure adequate ECG gated images and minimal motion artifact, patients in AF received beta-blockers and have CT scanning only if the heart rate controlled to less than 65%. The typical processing time for this method is 7–10 min. Standard fat attenuation values are used to define fat attenuation by CT; for non-contrast CT typically an attenuation range of (–30, –190) Hounsfield Units is used. Fat voxels within this attenuation range within the visceral pericardium are classified as epicardial fat, and within the inner thoracic cavity classified as thoracic fat (Fig. 2).[7]

2.3. Statistical analysis of the collected data

Results were collected, tabulated, and statistically analyzed using statistical Package of Social Science (SPSS) version 11