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Original article

# Can aortic atherosclerosis or epicardial adipose tissue volume be used as a marker for predicting coronary artery disease?

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ABSTRACT

*Purpose:* To investigate whether aortic atherosclerosis or epicardial adipose tissue (EAT) volume on multidetector computed tomography (CT) can predict the presence of significant coronary artery disease (CAD).

*Materials and methods:* Coronary CT angiography was performed in 202 cases of CAD that were known or based on suspicion. Based on coronary CT angiography results, the patients with significant stenosis (≥50%) and without significant stenosis (<50%) were compared in terms of demographic characteristics, traditional cardiovascular risk factors, aortic atherosclerosis, and EAT volume.

*Results:* Significant coronary artery stenosis was detected in 92 cases (45.5%). Although EAT volume was higher in the patients with significant stenosis, the difference between the two groups was not statistically significant. The presence of calcification in the descending aorta was significantly higher in the patients with significant stenosis than the patients without significant stenosis (50.4% and 15.4%, respectively, $p = 0.0001$). The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy rates of the presence of calcification in the descending aorta in predicting the presence of significant coronary artery stenosis were respectively found as 53.8%, 84.4%, 74.6%, 68.1%, and 70.3%. The sensitivity, specificity, PPV, NPV, and accuracy rates of the ≥2.45 mm wall thickness of the descending aorta in predicting the presence of significant coronary artery stenosis were respectively found as 75.3%, 74.3%, 71.4%, 77.9%, and 74.8%.

*Conclusion:* There is a strong relationship between thoracic aortic atherosclerosis and CAD. However, the relationship between EAT volume and CAD is not significant. The presence of aortic atherosclerosis can be used as an additional marker together with traditional cardiovascular risk factors for predicting CAD.



## Introduction

Aortic atherosclerosis, which plays a key role in the pathophysiology of ischemic stroke, can be used as a marker for coronary artery disease (CAD) [1–6]. Studies conducted with transesophageal echocardiography showed that thoracic aortic atherosclerosis was associated with cardiovascular risk factors and CAD [2]. In the studies conducted with magnetic resonance (MR) imaging, a relationship was detected between the prevalence of thoracic and abdominal aortic plaques and the severity of CAD [7]. Furthermore, in a study performed using electron-beam computed tomography (CT), Takasu et al. [8] reported that the thoracic aortic calcification detected in CT was highly specific for obstructive CAD.

Epicardial adipose tissue (EAT) is a type of visceral adipose tissue that functions like an endocrine organ by secreting adipocytokine and certain other hormones that contribute to the atherosclerotic process. It is considered that the epicardial adipose tissue contributes to the pathogenesis of CAD due to its closeness to the adventitia of the coronary arteries. The relationship between increased EAT and CAD was found to be significant in some studies. Sarin et al. [9] reported that increased (>100 mL) EAT volume could be used as a non-invasive marker for CAD, just as calcium score. However, since there are also studies [10–12] reporting that there is no significant relationship between increased EAT and CAD, studies that involve larger patient populations are required in order to obtain more precise data on this topic.

Since coronary CT angiography is reliable and non-invasive in the detection of CAD, it is a procedure with a gradually increasing clinical use despite radiation exposure. Coronary CT angiography provides information not only regarding coronary atherosclerosis, but also about thoracic aortic atherosclerosis within the scan area.

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Recently, it was found in the studies conducted with multidetector CT that descending aortic atherosclerosis was observed at a higher rate in cases with coronary artery stenosis compared to those without coronary artery stenosis [3,8,13–17]. Since thoracic or abdominal aortic atherosclerosis can be easily detected through routine thorax and abdomen CT examinations, it is important to determine whether aortic atherosclerosis can be used as a detection marker for CAD.

In the present study, which we conducted on a large patient population, we aimed to investigate the relationship among CAD and aortic atherosclerosis, EAT volume, and traditional cardiovascular risk factors and to determine whether aortic atherosclerosis or EAT volume can be used as a marker for predicting the presence of CAD.

## Materials and methods

### *Patient population*

A total of 419 cases of CAD that were known or based on suspicion underwent a coronary CT angiography examination from December 2011 to November 2012 at our institution. Overall, 201 patients who did not undergo a coronary artery calcium (CAC) score examination before coronary CT angiography and who had a coronary stent or bypass grafts were excluded from the study. Sixteen patients were excluded from the study when the coronary CT angiography examination was suboptimal, and the coronary arteries could not be sufficiently evaluated. A total of 202 cases [73 females, 129 males; median age 55.4 ± 12.4 years (range, 26–84 years)] were included in the study. Informed consent was obtained from all the patients, and the study was approved by the local ethics committee of our hospital.

### *Multi detector CT data acquisition*

A 64-detector CT scanner (Aquilion, Toshiba Medical Systems, Tokyo, Japan) and the same protocol were used for the examination of the patients. In the CAC score examination, an area from the carina level to the heart base was scanned with prospective electrocardiogram (ECG) triggering at a slice thickness of 3 mm (tube voltage, 120 kV; tube current, 300 mA). In the coronary CT angiography examination, an 80–100 mL iodinated contrast agent (Iomeron, Iomeprol 400 mgI/mL, Bracco, Milan, Italy or Iopromid, Ultravist 370 mgI/mL, Schering AG, Berlin, Germany) was administered through an 18–20 G cannula, which was placed in a cubital vein. Then, 40 mL saline was administered at the same rate. The optimal scan time was determined using the automatic bolus tracking method (Sure Start, Toshiba Medical Systems). The region of interest was placed over the descending aorta, and an adjustment was made to ensure that the scanning would automatically start when the maximum contrast reached 180 HU. The coronary CT angiography examination parameters were as follows: collimation, 64 mm × 0.5 mm; tube voltage, 120 kV; tube current, 400–500 mA; tube rotation time, 400 ms; slice thickness, 0.5 mm; and increment, 0.3 mm. A retrospective ECG-gated technique was used for the reconstruction of the images. The raw data that were obtained from the coronary CT angiography examination were reconstructed at the 75% phase (mid-diastolic phase) of the R–R interval using a slice thickness of 0.5 mm and an increment of 0.3 mm. For the cases in which this phase was not optimal for the image analysis, additional reconstructions were obtained at the 35–85% phase of the R–R interval.

### *Multi detector CT image analysis*

Two- and three-dimensional images were rendered using multiplanar reformatting, curved planar reformatting, maximum intensity projection, and volume rendering methods by transferring the obtained axial CT angiography images to a separate workstation (Vitrea 2, Vital Images, Minnetonka, MN, USA).

The Agatston method was used in the quantification of the CAC score. The left main coronary artery (LMCA), the left anterior descending (LAD) artery, the left circumflex (LCX) artery, and the right coronary artery (RCA) were examined for the presence of atherosclerotic plaques in the non-contrasted axial slices throughout their entire trace. The foci of the CAC were detected by one of two experienced radiologists and scored using semi-automatic commercial software to detect at least three contiguous pixels (voxel size, 1.03 $mm^3$) with a peak density ≥130 HU within a coronary artery.

The patients were divided into two groups according to the presence or absence of calcification in any region of the descending aortic wall.

For the evaluation of aortic wall thickness the cardiac CT angiography examinations were used. Wall measurements were performed using a defined window level setting (center 250, width 1000 HU) to optimize the wall visualization. Before the measurements, the images were magnified to about 400%. The maximum wall thickness of the descending aorta was measured perpendicular to the center of the vessel.

EAT was defined as the adipose tissue between the surface of myocardium and visceral layer of the pericardium (epicardium). Quantification of total EAT volume was done on a separate workstation (Advanced Workstation 4.2, GE, Milwaukee, WI, USA) with dedicated software (Volume Viewer, GE). A semi-automated volumetric method was developed for quantification of EAT. Using the 3-mm thick axial slices used for calcium scoring, we manually traced the outer border of the epicardium in every fourth slice starting from the aortic root to the apex of the heart. The number of slices that had to be traced manually ranged from 6 to 12 in each patient. The computer software then automatically interpolated and traced the epicardium in all the slices interposed between the manually traced slices. Total number of slices traced manually or automatically ranged from 30 to 40 in each patient, depending on the heart size. All the automatically traced slices were examined and verified for accuracy. Two histograms were generated to depict total cardiac volume and EAT volume. Fat voxels were identified using threshold attenuation values of −30 to −250 HU.

A modified American Heart Association classification that divided the coronary arterial system into 16 segments was used in the evaluation of the coronary arteries. In the coronary CT angiography images, each coronary artery segment was evaluated for the presence of a wall irregularity and/or the presence of an atherosclerotic plaque.

Each identified coronary artery lesion was assessed for stenosis severity along multiple longitudinal, transverse, and oblique axes with the use of multiplanar reconstructions, thin-slab maximum intensity projections, and curved reconstruction techniques. Coronary artery plaque was defined as any clearly discernible structure attributable to the coronary artery wall in at least two independent image planes. The degree of stenosis that was caused by the plaques was found by comparing the lumen diameter of the narrowest segment with that of a more proximal or distal normal segment. Stenoses were classified as non-significant in cases with a mean lumen diameter reduction of <50% or significant in cases with a mean lumen diameter reduction of ≥50% in two orthogonal projections. The patient groups with or without plaque as observed in coronary CT angiography were classified according to the demographic characteristics, the cardiovascular risk factors, the presence of aortic calcification in the descending aorta, the wall thickness of the descending aorta, and EAT volume and were statistically compared.