ROLE OF COMPUTED TOMOGRAPHY IN DETECTION OF THORACIC AORTA CALCIFICATION IN STABLE ANGINA PATIENTS

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Abstract

Background: Although the pathophysiology and clinical significance of thoracic aortic calcification are yet unknown, it is linked to atherosclerotic risk factors. The current study set out to determine whether patients with stable angina pectoris who also had calcification of the thoracic aorta had a higher chance of cardiovascular events and mortality.

Methods and Results: 152 individuals (98 men, 54 women; ages 35 to 80 years) with stable angina pectoris were included in a prospective cohort that had chest computed tomography to screen for aortic calcification. Over 1-year follow-up, we documented the incidence of cardiovascular events and deaths. There were 106 patients (70% of patients; 83 men and 23 women) with proven aortic calcification. Aortic valve calcification (28% against 11%; $p<0.001$), mitral annulus calcification (29% versus 4%; $p<0.001$), and coronary calcification were observed to be significantly correlated with the occurrence of aortic calcification in individuals. Cardiovascular events and mortality is noted significantly to be associated with thoracic aortic calcification ($p<0.001$).

Conclusions: Age-related calcification of the thoracic aorta is linked to valvular and coronary calcification. Cardiovascular illness and a higher risk of death are linked to thoracic aortic calcification.

KEYWORDS: Stable angina, Thoracic aorta, calcification

INTRODUCTION:

It has been shown that atherosclerosis of the thoracic aorta is a significant contributor to ischemic stroke.[1,2] It is linked to elevated rates of myocardial infarction (MI) and hypertension.[3] Thoracic aortic calcification is linked to valve and coronary calcification, both of which are indicative of an underlying atherosclerotic process. The pathophysiology and clinical significance of the intricate relationship between thoracic aortic calcification and

atherosclerosis are still unknown.[4] Plain radiographs showing aortic calcifications in the thoracic and abdominal regions are linked to a higher risk of cardiovascular and cerebrovascular events.[5]

Thoracic aortic calcification was independently associated with an increased risk of cardiovascular disease and an increased risk of ischemic stroke in women.[4,5] This clinical association was also demonstrated by spiral computed tomography (CT), which is rapidly evolving and effective noninvasive method for imaging cardiac calcification.[6,7] The objective of this study was to assess the incidence of thoracic aorta calcification as measured by spiral CT in determining its association with cardiovascular disease risk and mortality.

Methods

Study Population: All individuals presented with stable angina pectoris. The cardiovascular risk factors assessed included: high blood pressure, diabetes, high cholesterol, smoking, and a family history of coronary heart disease. The study is based on a multi-detector CT scan of patients with chronic angina who came to our institution. The study included 361 patients (307 men, 54 women; age range, 35 to 80 years) who met the inclusion criteria.

Inclusion Criteria: 3 categories of stable mobile patients of age ≥35 years, who presented with angina stable for at least 1 month, and requires per oral management in treating or preventing anginal attacks considered eligible for this study: (1) had previous episodes of MI, (2) without MI but with angiographic coronary artery disease, and (3) those without MI and angiographic coronary artery disease but with exercise test (+)

Exclusion Criteria: Those with pacemakers, and coronary artery bypass graft in-situ.

Image Acquisition: CT scan was done without injection of contrast material using Siemens Somatoform. Scanning time was 20 to 22 seconds for the entire zone of interest using 2.5-mm sections. Scanning is done in a deep inspiration. Coverage included from 5 to 6 cm of the proximal portion of the coronary tree, including the ascending aorta, and proximal 10 cm of the descending aorta, without covering the aortic arch. For calcium scoring, 40 continous sections were selected, starting from the first visible coronary artery (left main coronary artery or left anterior descending artery).

Determination of Calcification: If there is atleast one identifiable deposit of calcium in the wall of aorta it is considered to be a positive test for aortic calcification. Volume and area of calcification determines the calcification severity. CT imaging was used to identify aortic valve calcification and mitral valve calcification, which were characterized as the presence of visually observable calcified deposits in the area surrounding the aortic valve and the mitral annulus, respectively. A coronary calcified lesion is characterized by having a CT attenuation above 90 Hounsfield units (HU) and occupying a minimum area of 0.5 mm2 within a coronary artery.[8]

Agatston's scoring method[9] was modified by using a threshold of 90 HU instead of 130 HU. Additionally, an attenuation factor was determined for each lesion: 1=90 to 199 HU, 2=200 to 299 HU, 3=300 to 399 HU, and 4=400+ HU. The coronary calcium score for each region of interest was automatically calculated by multiplying the attenuation factor by the area.

Statistical Analysis: The analysis of the data was conducted using SPSS software. The associations between aortic calcification and baseline characteristics, risk factors, and coronary calcification were evaluated using the independent t-test for continuous variables and the χ2 test for categorical variables.

Two outcome measurements were evaluated: cardiovascular events (including cardiac cause of death, acute MI, refractory angina, and stroke) and mortality. The association between these outcomes and aortic calcification was examined using Fisher's exact test for categorical variables and an independent t test for continuous variables.

Result:

A total of 152 patients with stable angina pectoris were included in the study. The aortic calcification group included 106 patients (70% of all patients; 83 men, 23 women; mean age, 65±7 years; age range, 41 to 83 years). The comparison group (non–aortic calcification group) included 46 patients (24 men, 22 women; mean age, 55±9 years; age range, 37 to 77 years). Patients with aortic calcification were older (p<0.001) and fewer were classified as smokers (13% versus 26%; p=0.014) compared with their counterparts without aortic calcification. Medications of patients with compared with those without aortic calcification included more calcium channel blockers, angiotensin-converting enzyme inhibitors, and diuretics (p=0.047, p=0.043, and p=0.018, respectively). There were no additional statistically significant intergroup differences regarding risk factors for atherosclerosis as shown in Table 1.

Table 1 Characteristics of patients included in study

Characteristic	With Aortic Calcification (n=106)	Without Aortic Calcification (n=46)	p-value
Age	65±7 years	55±9 years	<0.001
Gender (M:F)	83:23	24:22	0.314
Hypertension	52%	55%	0.154
Diabetes mellitus	26%	27%	0.247
Family history of coronary heart disease	32%	44%	0.541
Smoking	13%	26%	0.014
Hypercholesterolemia	74%	70%	0.165

Significant differences were found between patients with and without aortic calcification for the presence of aortic valve calcification (28% versus 11%; p<0.001), mitral annulus calcification (29% versus 4%; p<0.001), and coronary calcification as expressed by coronary calcium score (p<0.001). Sixty had cardiovascular events (18.9% of patients with aortic calcifications versus 11.1% in those without; p=0.043), which included cardiac cause of death, acute MI, refractory angina, and stroke (8 versus 0 events, 21 versus 5 events, 12 versus 5 events, and 7 versus 2 events, respectively). Total events also included non-cardiac cause of death, heart failure, and

peripheral revascularization (9 versus 0 events, 7 versus 0 events, and 11 versus 2 events, respectively). A total of 19 patients died during follow-up, all of whom were in the aortic calcification group: 8 deaths were attributed to cardiac cause, 9 were determined to be non-cardiac cause, and 2 were of unknown cause.

To assess whether the association between aortic calcification and rate of cardiovascular and total events persisted in diverse categories, rate of events was determined in patients according to current smoking, sex, age, history of MI, and coronary artery bypass graft. A higher incidence of cardiovascular events and total events was found in aortic calcification subgroups regardless of these characteristics, except for cardiovascular events in woman ($p<0.001$).

Discussion

Multidetector CT is a swiftly advancing and efficient noninvasive method for cardiac imaging that is gaining popularity. This method has significantly progressed with the introduction of multirow detector CT scanners that offer quicker acquisition speed. Lately, there has been a growing interest in vascular calcification and its correlation with clinical results. It is common knowledge that calcification is linked to atherosclerosis, however, whether it directly harms or is merely an indicator of atherosclerotic burden remains uncertain. Research on coronary arteries has shown a connection between calcification and cardiovascular incidents, specifically heart attacks.[10] The correlation between atherosclerosis and calcification of the thoracic aorta is intricate. Unlike the atherosclerotic characteristic of coronary calcification, aortic calcification can be categorized into two pathophysiological mechanisms: intimal, which is mainly atherosclerotic, and medial, which is non-atherosclerotic.[10]

Though differentiation between calcifications of intima and media in CT cannot be precisely made out, yet it is considered highly sensitive method for vascular calcium identification. In the past few years, several studies have demonstrated the correlation among calcification in the coronary, valvular, and aortic regions. Several trials have confirmed the hypothesis that aortic calcification is linked to an underlying atherosclerosis process. These trials have shown an elevated risk of cardiovascular and cerebrovascular events in patients with aortic calcification detected through various imaging techniques.

We evaluated the proposition that aortic calcification holds significant clinical implications for the prognosis and occurrences in patients with stable angina pectoris. Our findings indicate a strong correlation between aortic calcification, as determined through CT scans, and both mortality and cardiovascular events. We have proven that the prevalence of descending aortic calcification surpasses that of ascending aortic calcification, as well as the combined occurrence of both ascending and descending calcification, in all events. The higher severity of calcification in the descending aorta, compared to the other subgroups, outweighs this fact. Hence, calcification in the descending aorta might serve as a more reliable indicator of an elevated burden of vascular disease, surpassing the significance of ascending aortic calcification. This discovery lacks an evident reason and warrants further examination. Another aspect that requires clarification is the potential connection between aortic calcification and overall mortality.

Budoff and colleagues examined over 25,000 patients in an observational outcomes study and discovered that coronary artery calcium offers supplementary information beyond traditional risk factors in forecasting all-cause mortality.[4] The correlation was also observed among elderly male patients, as indicated by previous studies.[5] However, only a limited number of studies have attempted to investigate the potential link between aortic calcification and overall mortality. Notably, abdominal aortic calcification was found to be associated with all-cause mortality in both hemodialysis patients and elderly women.[6,7] Moreover, echocardiography has shown that aortic annular calcification is linked to both cardiovascular and all-cause mortality in elderly individuals who already have cardiovascular disease. This association was observed in a study involving older patients.

There has been no research conducted on the link between thoracic aortic calcification and overall mortality in patients with stable angina pectoris using CT scans. Despite the limited number of fatalities in our study, we have shown this connection. The reason behind the relationship between calcification and mortality is still unknown, but our findings support the theory that aortic calcification is linked to atherosclerosis. However, it is still uncertain which other factors play a role in this process.

Our study is constrained by various factors related to patient characteristics. Our research sample was also restricted to individuals with stable angina pectoris, thus caution should be exercised when applying these findings to other groups. Additionally, it is important to note that we were unable to detect noncalcified atherosclerotic plaques, and the assessment of the aortic arch was not conducted, which further limits the scope of our study. Among our specific patient population, those with aortic calcification were considerably older than their counterparts who did not have aortic calcification.

Conclusions

The current investigation reveals that the calcification of the thoracic aorta is extensively common among patients with stable angina pectoris. This condition is closely linked to age and is also associated with the calcification of the coronary arteries and heart valves. Notably, the presence of thoracic aortic calcification, especially in the descending aorta, is correlated with a higher risk of mortality and cardiovascular ailments.

REFERENCES

1. Alexopoulos D, Toulgaridis T, Davlouros P, Christodoulou J, Sitafidis G, Vagenakis AG. Prognostic significance of coronary artery calcium in asymptomatic subjects with usual cardiovascular risk. American heart journal. 2003 Mar 1;145(3):542-8.
2. O'Malley PG, Taylor AJ, Jackson JL, Doherty TM, Detrano RC. Prognostic value of coronary electron-beam computed tomography for coronary heart disease events in asymptomatic populations. The American journal of cardiology. 2000 Apr 15;85(8):945-8.
3. Proudfoot D, Shanahan CM. Biology of calcification in vascular cells: intima versus media. Herz. 2001 Jun;26:245-51.

4. Budoff MJ, Shaw LJ, Liu ST, Weinstein SR, Tseng PH, Flores FR, Callister TQ, Raggi P, Berman DS, Mosler TP. Long-term prognosis associated with coronary calcification: observations from a registry of 25,253 patients. Journal of the American College of Cardiology. 2007 May 8;49(18):1860-70.

5. Okuno S, Ishimura E, Kitatani K, Fujino Y, Kohno K, Maeno Y, Maekawa K, Yamakawa T, Imanishi Y, Inaba M, Nishizawa Y. Presence of abdominal aortic calcification is significantly associated with all-cause and cardiovascular mortality in maintenance hemodialysis patients. American Journal of Kidney Diseases. 2007 Mar 1;49(3):417-25.

6. Abbott RD, Ueshima H, Masaki KH, Willcox BJ, Rodriguez BL, Ikeda A, Yano K, White LR, Curb JD. Coronary artery calcification and total mortality in elderly men. Journal of the American Geriatrics Society. 2007 Dec;55(12):1948-54.

7. Okuno S, Ishimura E, Kitatani K, Fujino Y, Kohno K, Maeno Y, Maekawa K, Yamakawa T, Imanishi Y, Inaba M, Nishizawa Y. Presence of abdominal aortic calcification is significantly associated with all-cause and cardiovascular mortality in maintenance hemodialysis patients. American Journal of Kidney Diseases. 2007 Mar 1;49(3):417-25.

8. Shemesh J, Apter S, Rozenman J, Lusky A, Rath S, Itzchak Y, Motro M. Calcification of coronary arteries: detection and quantification with double-helix CT. Radiology. 1995 Dec;197(3):779-83.

9. As A. Quantification of coronary artery calcium using ultrafast computed tomography. J Am Coll Cardiol. 1990;15:827-32.

10. Farzaneh-Far A. Origins and consequences of vascular calcification. Jama. 2000 Sep 27;284(12):1515-6.