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Relationship between Coronary Artery and Descending Thoracic Aortic Calcification as Detected by Computed Tomography: the Multi-Ethnic Study of Atherosclerosis

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Abstract

Background—Cardiac computed tomography (CT) is a well-established tool for the detection of cardiovascular calcium. Coronary artery calcification (CAC) is highly sensitive for the detection of coronary artery disease (CAD) as well as predictive of future cardiovascular (CV) events. Descending thoracic aortic calcification (DTAC) is common in the elderly and its presence is also associated with increased risk of CV events. Previous studies demonstrate that DTAC is associated with obstructive CAD and coronary risk factors. However, no prior studies have examined the association of CAC and DTAC as detected by cardiac CT in a large population-based cohort.

Methods—In the Multi-Ethnic Study of Atherosclerosis, the study population included a population based sample of four ethnic groups (Chinese, White, Hispanic and African-American) of 6814 women and men ages 45–84 years old. Participants underwent non-enhanced cardiac CT and both CAC and DTAC were quantified. DTAC was measured from the lower edge of the pulmonary artery bifurcation to the cardiac apex. Multivariable relative risk regression was used to evaluate relationships between CAC, DTAC and measured cardiovascular risk factors.

Results—Overall 3030 (44%) did not demonstrate any detectable CAC or DTAC. A total of 1930 (28%) had only CAC, 386 (6%) had isolated DTAC, and 1464 (22%) participants were found to have both CAC and DTAC. CAC had a higher prevalence than DTAC in men (58% vs. 45%). Participants with DTAC were older than those with CAC (mean age was 71 and 66 years old, respectively). Participants with DTAC had increased risk for the presence of CAC independent of cardiovascular risk factors (prevalence ratio [PR]; 1.17 95% CI 1.07–1.28). Severity of DTAC was a stronger predictor of the presence of CAC in women as compared to men (PR; 1.04 95% CI 1.02–1.06, and PR; 0.99 95% CI 0.98–1.01, respectively).

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Conclusions—DTAC was found to be a strong predictor of CAC independent of CV risk factors. Ongoing follow-up of this cohort will evaluate whether DTAC is an independent marker of risk for CV events.

Introduction

Several studies on aortic atheroma using transesophageal echocardiography (TEE) have shown that aortic atherosclerosis was associated with coronary artery disease (CAD)^{1,2,3,4,5}. TEE, however, is invasive and difficult to apply to a large population based study. Non-enhanced computed tomography (CT) can measure vascular calcification and is a non-invasive modality with a low burden on subjects. Coronary artery calcification detected by CT documents the presence of coronary atheroma and has been shown to add to the prediction of hard cardiovascular (CV) events beyond traditional CV risk factors in both men, women and four major ethnic groups in the U.S.^{6,7,8,9,10}. The patients with calcification in the descending thoracic aorta have 3.8 times the relative risk for obstructive coronary artery disease (CAD) independent of age.¹¹ Although the prevalence of descending thoracic aortic calcification (DTAC) is relatively low in people under age 60, it increases significantly with age¹².

No previous study has examined the relationship of coronary artery and thoracic aortic calcium as detected by computed tomography (CT) in a large population based cohort. The aim of this paper is to determine the relationships between CAC and DTAC with traditional CV risk factors including gender and age.

Methods

The Multi-Ethnic Study of Atherosclerosis (MESA) was initiated in July 2000 to investigate the prevalence, correlates and progression of subclinical cardiovascular disease in individuals without known cardiovascular disease¹³. This prospective cohort study includes 6814 women and men ages 45–84 years old recruited from six U.S. communities (Baltimore, MD; Chicago, IL; Forsyth County, NC; Los Angeles County, CA; northern Manhattan, NY; and St. Paul, MN) who identified themselves as white, African-American, Hispanic, and Chinese.

Medical history, anthropometric measurements, and laboratory data for the present study were taken from the first examination of the MESA cohort (July 2000 to August 2002). Information about age, gender, ethnicity, and medical history were obtained by questionnaires. Current smoking was defined as having smoked a cigarette in the last 30 days. Diabetes was defined as a fasting glucose ≥ 126 mg/dl or on hypoglycemic medication. Use of antihypertensive and other medications were based on clinic staff entry of prescribed medications.

Resting blood pressure was measured three times in the seated position using a Dinamap model Pro 100 automated oscillometric sphygmomanometer (Critikon, Tampa, Florida) and the average of the last two readings was recorded. Hypertension was defined as a systolic blood pressure ≥ 140 mmHg, diastolic blood pressure ≥ 90 mmHg, or use of medication prescribed for hypertension. Body mass index was calculated from the equation weight (kg)/ height (m²).

Total and HDL cholesterol were measured from blood samples obtained after a 12-hour fast. LDL cholesterol was calculated with the Friedewald equation⁽¹¹⁾. CRP was measured using the BNII nephelometer (N High Sensitivity CRP; Dade Behring Inc., Deerfield, IL) at the Laboratory for Clinical Biochemistry Research (University of Vermont, Burlington, VT). Analytical intra-assay CVs ranged from 2.3 – 4.4% and inter-assay CVs ranged from 2.1 – 5.7%. IL-6 was measured by ultra-sensitive ELISA (Quantikine HS Human IL-6 Immunoassay; R&D Systems, Minneapolis, MN). The laboratory analytical CV for this assay

was 6.3%. Fibrinogen was measured using a BNII nephelometer (N Antiserum to Human Fibrinogen; Dade Behring Inc., Deerfield, IL) with intra-assay and inter-assay analytical CVs of 2.7% and 2.6%, respectively. Factor VIII levels were determined by measuring the clot time of a sample in factor VIII deficient plasma in the presence of activators utilizing the Sta-R analyzer (STA-Deficient VIII; Diagnostica Stago, Parsippany, NJ).

All participants underwent two CT scans at the same time for evaluation of CAC, after signing informed consent. An ancillary study, supported by the National Institutes of Health, was performed to measure aortic and valvular calcification on the scans obtained for the MESA study. This study was approved by the Institutional Review Board of our institution. Three sites used an Imatron C-150XL CT scanner (GE-Imatron, San Francisco, CA), and three sites used a multidetector CT scanner (four slice). The method has been reported previously¹⁴. Image slices were obtained with the participant supine, with no couch angulation. A minimum of 35 contiguous images with a 2.5- or 3-mm slice thickness was obtained, starting above the left main coronary artery to the bottom of both ventricles. Each scan was obtained in a single breath hold. Section thickness of 3 mm, field of view of 35 cm, and matrix of 512×512 were used to reconstruct raw image data. The nominal section thickness was 3.0 mm for electron beam CT and 2.5 mm for four-detector row CT. Spatial resolution can be described by the smallest volume element, or voxel, for the protocol for each system: 1.15 mm^3 for four-detector row CT ($0.68 \times 0.68 \times 2.50 \text{ mm}$) and 1.38 mm^3 for electron beam CT ($0.68 \times 0.68 \times 3.00 \text{ mm}$). Descending thoracic aortic calcification (DTAC) was measured on images starting at the lower edge of the pulmonary artery bifurcation inferiorly to the cardiac apex. This region of the thoracic aorta was included on the images on every study of coronary calcium and was quantified by using the same lesion definition (threshold and minimum lesion size) as was used for coronary calcification. The absence of CAC and DTAC was assigned a score of 0.

Statistical Methods

CAC and DTAC were dichotomized as present (Agatston score > 0) or absent (Agatston score $= 0$). Distributions of demographics and cardiovascular risk factors were compared across these groups. Differences in characteristics were compared using ANOVA for continuous variables and χ^2 tests for categorical variables. Because the prevalence of CAC in our cohort is greater than 10%, odds ratios (ORs) overestimate the prevalence ratios (PR). Therefore, PR estimates are presented from the regression model $y = \exp(\mathbf{X}^T \boldsymbol{\beta})$. The exponentiated parameters $\boldsymbol{\beta}$ are interpreted as PR. That is, the probability of detectable CAC was modeled as a function of covariates using a generalized linear model with log link and binomial error distribution. In some cases the model failed to converge with the binomial error, hence we assumed Gaussian error and used robust standard error estimates. Using this method we assessed the relationship between DTAC and the presence of CAC. A simple approach to separate the qualitative difference between absence and presence of DTAC from the quantitative effect of DTAC was used. DTAC was modeled as a dichotomous variable (DTAC=0 versus DTAC >0) and continuous variable ($\ln(\text{DTAC}+1)$) in the same model adjusting for potential confounders. Covariates were entered into the regression model adjusting for demographics (age, gender, and race), cardiovascular risk factors (BMI, HDL, LDL, lipid lowering medication, smoking, hypertension, diabetes mellitus and family history of heart attack) and markers of inflammation (IL-6, fibrinogen and factor VIII). Two-way interactions between DTAC and age, gender and race with CAC as the outcome were examined. We also used the same regression method to look at risk factors separately for CAC and DTAC as dichotomous outcomes. Statistical analyses were performed with SPSS 15.0 software for Windows (SPSS Inc, Chicago, Ill) and STATA 10.0 for Windows (Stata Co, College Station, TX).

Results

A. Participant characteristics

The study population (6814 individuals, 49% men and mean age: 63 ± 10 years) was split according to distribution and frequency of presence of CAC and DTAC. Overall 3030 (45%) did not demonstrate any detectable CAC or DTAC. A total of 1930 (28%) had only CAC, 386 (6%) had isolated DTAC, and 1464 (22%) participants were found to have both CAC and DTAC. One participant had uninterpretable data for DTAC. Three participants were excluded due to the presence of renal failure based on the potential for altered calcium metabolism with renal failure to influence the measurement of DTAC.

Table 1 demonstrates the baseline characteristics of the study population between DTAC and CAC. The overall prevalence of DTAC was 27% and of CAC was 50%. The ethnic makeup of the MESA cohort for prevalence of DTAC and CAC were similar. The prevalence of DTAC by ethnicity was 45% White, 14% Chinese, 21% African-American, and 20% Hispanic and the prevalence of CAC ethnicity was 44%, 12%, 24%, and 20%, respectively. CAC had a higher prevalence in men (58% CAC versus 45% DTAC). Participants with DTAC were significantly older than participants with CAC (mean age was 71 and 66 years old, respectively), had more hypertension (65% DTAC versus 55% CAC), and higher levels of IL-6 (median of 1.42 for DTAC and 1.31 for CAC).

DTAC status by absence/presence of CAC is shown in table 2. Participants with no CAC had an 11% prevalence of DTAC compared to a prevalence of 43% for participants with CAC > 0 ($p < 0.001$). Similarly by defining quantity of DTAC as $\ln(\text{DTAC} + 1)$, participants with no CAC had a significantly lower mean score compared to those with CAC > 0 (mean = 0.53, SD = 1.87 and mean = 2.45, SD = 3.02, respectively, $p < 0.001$).

Figure 1 shows the prevalence CAC by presence/absence of DTAC plus quartiles of DTAC for participants with DTAC > 0. Similarly, figure 2 shows the prevalence of DTAC by CAC quartiles. Severity of CAC and DTAC increased with prevalence of DTAC and CAC respectively. The prevalence of DTAC went from 6% without CAC (score of zero) to over 60% with CAC scores > 299. The prevalence of CAC went from 39% for those without DTAC to 92% for those with DTAC > 833.

B. Association of DTAC and CAC with risk factors

Multivariable prevalence ratio estimates for risk factors associated with the presence of CAC and DTAC are shown in table 3. DTAC was more strongly associated with age than CAC. A 10-year age increase was associated with a 99% risk increase in the prevalence of DTAC compared to a 37% increase in CAC. The risk of prevalent DTAC was lower among men than women (PR 0.87, 95% CI 0.82–0.94) while the prevalence of CAC was higher in men (PR 1.38, 95% CI 1.32 and 1.44). Among noted risk factors, hypertension and current smoking status were most strongly associated with the presence of DTAC (PR 1.44, 95% CI 1.30–1.60 and PR 1.35, 95% CI 1.26–1.46, respectively) while multiple risk factors were significantly associated with the prevalence of CAC. The most strongly associated was current smoking, with a PR of 1.24 (95% CI 1.16–1.32).

Ethnic differences were also observed. Overall African-Americans and Hispanics were less likely to have any CAC and DTAC compared to Whites. After multivariable adjustment, African-Americans had the lowest PR of DTAC (0.65 95% CI 0.59–0.74) as well as CAC (PR 0.76 95% CI 0.72–0.80) as compared with whites. Chinese were not statistically different to whites for both DTAC and CAC (PR 1.05, 95% CI 0.96–1.16 and PR 0.93, 95% CI 0.86–1.00, respectively).

C. Association of DTAC with CAC

Table 4 shows the association of CAC with the prevalence and severity of DTAC. After adjustment for risk factors the presence and severity of DTAC were significantly associated with CAC (PR 1.17, 95% CI 1.07–1.28 and 1.02, 95% CI 1.01–1.03 respectively). A significant interaction was found between severity of DTAC and gender (p-value <0.001 in the fully adjusted model). Table 5 shows the association of DTAC and CAC stratified by gender. In both men and women the presence of DTAC was independently and similarly associated with CAC in unadjusted models (PR 1.42 95% CI 1.28 – 1.57, and PR 1.43 95% CI 1.22 – 1.67, respectively). However, in women the severity of DTAC was a stronger predictor of CAC presence than men and remained significant after multivariate adjustment (PR 1.04, 95% CI 1.02–1.06 and PR 0.99, 95% CI 0.98–1.01 respectively).

Discussion

This study found a fairly strong relationship between CAC and DTAC. The implications are significant, as DTAC can be obtained and potentially quantified on non-gated CT scans of the lung (diagnostic lung CT or cancer screening). If DTAC is present, additional risk stratification of patients for cardiovascular disease may be warranted. Large cohort studies to investigate the association between DTAC and CAC using CT are limited. In a relatively large population based study, however, Wong et al have reported thoracic aortic calcification and CAC by cardiac CT¹⁵ in 2,740 asymptomatic patients. The prevalence of DTAC and CAC in that study was higher than the MESA cohort because the population consisted of patients with multiple cardiovascular risk factors and MESA cohort included large numbers of African-American and Hispanic patients who demonstrated lower prevalences of DTAC than Whites. In both this study and the study by Wong, DTAC demonstrated greater prevalence in women than men. One association that may predispose women to higher levels of DTAC is osteoporosis, as there is emerging data that atherosclerosis and osteoporosis are inter-related.^{16,17,18,19,20}

Furthermore, reports on atherosclerotic plaques have shown that arterial calcification has osteoblastic-like mechanisms, as many bone-forming proteins are expressed in arterial calcification.^{21,22,23,24,25,26} In addition, oxidized lipids and growth factors, such as TGF- β , can paradoxically inhibit bone formation, yet stimulate atherosclerotic calcification²⁷. These reports suggest that similar factors may promote both osteoporosis and aortic calcification, thereby accounting for the greater prevalences of both osteoporosis and aortic calcification in women as compared to men. Allison et al has demonstrated that the calcifications in all vascular beds increased with age.¹² Wong et al also demonstrated that TAC increased with age more than CAC independently of noted risk factors²¹ (Odds per 10 years; 4.35 and 3.15, respectively). This study also showed that the trend of both DTAC and CAC increased with age (PR per 10 years; 1.99 and 1.37, respectively). The prevalence of DTAC by presence and extent of CAC in this study (Figure 2) are consistent with the results of Wong et al¹⁵. However, almost half of patients had DTAC of zero in participants with severe CAC (Agatston score > 299).

Regarding ethnicity, White and Chinese participants demonstrated increased prevalence of DTAC and CAC in comparison with African-Americans and Hispanics. Bild et al previously reported CAC in the MESA cohort and demonstrated that African-Americans had lower prevalence than Whites.²⁸ Ethnic trends were similar for DTAC and CAC, with greater differences for DTAC between African-Americans and Whites than CAC (Table 3). The severity of DTAC and CAC paralleled each other more closely in the Chinese cohort than the other ethnic/racial groups. Whether DTAC in Chinese are more closely related to outcomes will be determined as long term follow up of this cohort continues.

Risk factors for presence of DTAC and CAC were overall similar. However, current smoking and hypertension were stronger independent risk factors of DTAC than CAC. Interestingly,

there was a slightly higher prevalence of current smoking (13.5% vs. 11.7%, $p=0.04$) in the DTAC group with zero calcification, than DTAC>0. Neovascularization of atherosclerotic plaques by nicotine contributes to progression of atherosclerosis²⁹, and release of endogenous epinephrine by nicotine influences cardiac function and blood pressure³⁰, which may place more direct stress on the aorta than the coronary arteries. Smoking cessation was associated with decreased atherosclerotic risk in both the aorta and coronary arteries (PR for current smoker; 1.44 and 1.24, and PR for former smokers; 1.10 and 1.11, respectively). Hypertension more strongly influenced the aorta as compared to the coronary artery. Aortic stiffness closely associated with aortic calcification is directly related to pulse pressure³¹, and elevates systolic blood pressure.³² These results demonstrate that hypertension was more related to the prevalence of DTAC than CAC. High LDL, low HDL and lipid lowering medication use independently increased both DTAC and CAC. Mean values of LDL and HDL between two groups according to the presence of DTAC were exactly the same and the values were modified by lipid lowering meds. Despite them, high LDL and low HDL increased the prevalence of DTAC after adjustment of risk factors. Goff et al reported on dyslipidemia prevalence, treatment and control of the MESA cohort,³³ with an overall prevalence of dyslipidemia of 29.3%, only 53.9% were treated. Nonetheless, lipid lowering medication utilization was associated with the presence of DTAC and CAC independent of other risk factors. In a subsequent study of 4468 patients by Wong et al, total cholesterol values and taking lipid lowering medications significantly increased TAC independently of noted risk factors³⁴. Pre-treatment lipid profiles may explain the predilection of calcification in statin users, but these were generally not available, as statins were instituted prior to the start of MESA in many participants. Following development of both DTAC and CAC in MESA with repeat CT studies should shed insight into the relationship between statin use and calcification.

Since both vascular beds (aorta and coronary arteries) are exposed to the same risk factors for atherosclerosis, it is no surprise that DTAC parallels CAC (figure 3). As extra-coronary calcifications including DTAC is detectable with CAC scanning, evaluating and possibly quantifying these calcifications may give additional information about CV risk and may predicting CV events.

The present study based on the MESA cohort has several limitations which have been described previously.²⁸ The participation rate was approximately 30% of those contacted, which is low enough that bias could have been introduced, although similar recruitment methods were used in all ethnic groups, and the participation among those screened (for whom ethnicity was collected) was 70% of whites, 61% of blacks, 59% of Hispanics, and 48% of Chinese. A scoring method for DTAC was used which was identical to the Agatston score for CAC, however there is no histologic or other validation to validate this DTAC scoring method. Also, two types of CT scanners were used for this study, and previous studies have demonstrated that the concordance for presence of calcium between duplicate scans was high and similar for both electron-beam and multi-detector row CT (96%, $p=0.92$). This previous analysis demonstrated that electron-beam and multi-detector row CT scanners have equivalent reproducibility for measuring coronary artery calcium.³⁵ We have also demonstrated that the reproducibility of TAC is not significantly different between scanner types.³⁶

Previous reports from the MESA cohort verified and considered some characteristics of aortic calcification related to noted risk factors, ethnicity and inflammatory markers^{37,38,39,40}. The prevalence of ascending thoracic aortic calcification, however, was very low and did not influence the prevalence and the severity of the total thoracic aortic calcification (ascending and descending thoracic aortic calcification). For these reasons, we excluded ascending aortic calcification and only used DTAC. The MESA cohort at baseline excluded persons with symptomatic CAD who would develop atherosclerotic involvements. We could not investigate an association between DTAC and obstructive CAD, as participants neither routinely

underwent coronary CT angiography or cardiac catheterization. These potential biases could lead to underestimate the prevalence and the severity of DTAC and CAC compared to general population, and may lower the prevalent ratio for risk factors.

DTAC demonstrated a low prevalence in all age groups compared to CAC, but abruptly increased in the elderly. In subgroups according to gender and ethnicity, DTAC had close relations to CAC in middle aged women and 3 ethnic groups (Chinese, African-American and Hispanic). As for noted risk factors, lipid profiles exhibited a similar risk for both DTAC and CAC, and current smoking and hypertension were stronger risk factors of DTAC while diabetes was a stronger risk of CAC. In the light of these results, MESA participants are being followed in regards to an association between DTAC and cardiovascular events to evaluate if this method provides incremental information to the clinician. Given the strong relations between DTAC and CAC, and the association to risk factors, it is possible that the DTAC measures that are available on non-gated lung CT scans could be quantified and used as a marker of atherosclerotic risk. Given the millions of these scans done annually, greater attention should be turned to the incidental finding of DTAC.

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Figure 1. Prevalence of coronary calcium score > 0 by descending aortic calcium
Categories were selected by 0 and quartile of those positive

Figure 2.
Prevalence of descending aortic calcium > 0 by coronary calcium score.

Distribution of CAC for those with DTAC=0 and DTAC>0

Figure 3.
Distribution of Coronary Artery Calcium for those with Descending Aortic Calcium.

Table 1
Characteristics of MESA absence/presence of Descending Thoracic calcification and coronary calcium.

Variables**	DTAC=0	DTAC>0	p-value	CAC=0	CAC>0	p-value
N (%)	4960 (73%)	1850 (27%)		3416 (50%)	3393 (50%)	
Age	59 (9)	71 (8)	<0.001	58 (9)	66 (10)	<0.001
Men	2381 (48%)	829 (45%)	0.019	1249 (37%)	1961 (58%)	<0.001
Race						
White	1788 (36%)	835 (45%)	<0.001 [†]	1127 (33%)	1496 (44%)	<0.001 [†]
Chinese	544 (11%)	259 (14%)	0.001 [†]	399 (12%)	404 (12%)	0.772 [†]
African-Americans	1497 (30%)	396 (21%)	<0.001 [†]	1073 (31%)	820 (24%)	<0.001 [†]
Hispanic	1131 (23%)	360 (20%)	0.003 [†]	817 (24%)	674 (20%)	<0.001 [†]
Smoking						
Former	1755 (36%)	729 (40%)	0.002	1045 (31%)	1439 (43%)	<0.001
Current	671 (14%)	216 (12%)	0.041	451 (13%)	436 (13%)	0.613
BMI (Kg/m ²)	29 (6)	28 (5)	<0.001	28 (6)	28 (5)	0.821
Systolic BP (mmHg)	123 (20)	136 (23)	<0.001	122 (20)	131 (22)	<0.001
Diastolic BP (mmHg)	72 (10)	72 (10)	0.082	71 (10)	73 (10)	<0.001
anti-hypertensive medication	1568 (32%)	964 (52%)	<0.001	984 (29%)	1548 (46%)	<0.001
Hypertension	1856 (37%)	1198 (65%)	<0.001	1200 (35%)	1854 (55%)	<0.001
Diabetes	620 (13%)	348 (19%)	<0.001	364 (11%)	604 (18%)	<0.001
Family history of heart attack	1918 (41%)	813 (48%)	<0.001	1203 (37%)	1528 (48%)	<0.001
Total cholesterol	194 (35)	195 (36)	0.204	194 (35)	195 (36)	0.305
LDL (mg/dL)	117 (32)	117 (31)	0.826	116 (31)	118 (32)	0.002
HDL (mg/dL)	51 (15)	51 (14)	0.693	53 (15)	49 (15)	<0.001
Triglycerides* (mg/dL)	109 [76, 159]	117 [83, 164]	<0.001	106 [75, 155]	117 [82, 166]	<0.001
Lipid lowering meds	652 (13%)	446 (24%)	<0.001	360 (11%)	738 (22%)	<0.001
CRP* (mg/dL)	1.87 [0.81, 4.27]	1.99 [0.92, 4.20]	0.038	1.93 [0.83, 4.31]	1.91 [0.85, 4.19]	0.750
Interleukin-6* (pg/mL)	1.12 [0.72, 1.79]	1.42 [0.93, 2.14]	<0.001	1.10 [0.70, 1.76]	1.31 [0.87, 2.02]	<0.001
Fibrinogen (mg/dL)	342 (73)	360 (75)	<0.001	340 (71)	354 (76)	<0.001
Factor VIII (%)	160 (67)	174 (67)	<0.001	157 (65)	170 (69)	<0.001

BMI = body mass index; BP = blood pressure; CAC = coronary artery calcium; CRP = C reactive protein; DTAC = descending thoracic aortic calcification; HDL = high density lipoprotein; LDL = low density lipoprotein; SD = standard deviation

* median[IQR]
** represented as Mean ± SD or N (%)
‡ = p value reflects uneven distribution of DTAC and CAC by ethnicity. Only Chinese participants had equal proportions of CAC 0 and CAC >0 (399 vs 404, p=ns).

Table 2

Descending thoracic calcification status by absence/presence of coronary calcium.

Characteristic	CAC=0 (n=3416)		CAC>0 (n=3394)	
	N (%)	Mean (SD)	N (%)	Mean (SD)
DTAC status				
DTAC=0	3030 (89)		1930 (57)	
DTAC>0	386 (11)		1464 (43)	
Continuous				
DTAC				
Ln(DTAC+1)		0.53 (1.59)		2.45 (3.02)

CAC=coronary artery calcium; DTAC = descending thoracic aortic calcification

Table 3
Multivariable risk factor analysis for presence of Descending Thoracic calcification and Coronary Calcium.

Variable	PR	DTAC 95% CI	p-value	PR	CAC 95% CI	p-value
Age (per 10 yr)	1.99	1.92, 2.06	<0.001	1.37	1.34, 1.40	<0.001
Gender (Female vs Male)	0.87	0.82, 0.94	<0.001	1.38	1.32, 1.44	<0.001
Race						
White	1.00 (ref)	--	--	1.00 (ref)	--	--
Chinese	1.05	0.96, 1.16	0.272	0.93	0.86, 1.00	0.049
African-American	0.65	0.59, 0.74	<0.001	0.76	0.72, 0.80	<0.001
Hispanic	0.83	0.77, 0.91	<0.001	0.84	0.80, 0.89	<0.001
Former smoker	1.10	1.03, 1.17	0.003	1.11	1.06, 1.16	<0.001
Current smoker	1.44	1.30, 1.60	<0.001	1.24	1.16, 1.32	<0.001
BMI (per SD=5.5)	0.96	0.93, 1.00	0.062	1.04	1.02, 1.07	<0.001
Hypertension	1.35	1.26, 1.46	<0.001	1.14	1.09, 1.19	<0.001
Diabetes	1.09	1.00, 1.18	0.048	1.11	1.05, 1.17	<0.001
Family history of heart attack	1.10	1.03, 1.17	0.003	1.16	1.11, 1.21	<0.001
LDL (per SD=31)	1.06	1.03, 1.10	<0.001	1.07	1.05, 1.09	<0.001
HDL (per SD=15)	0.95	0.91, 0.94	0.005	0.96	0.94, 0.99	0.004
Lipid lowering meds	1.15	1.07, 1.23	<0.001	1.18	1.12, 1.23	<0.001
CRP (per SD=5.89)	1.00	0.97, 1.03	0.986	1.00	0.97, 1.02	0.683
Interleukin-6 (per SD=1.22)	1.03	1.00, 1.06	0.067	1.02	0.99, 1.04	0.074
Fibrinogen (per SD=74)	1.04	1.01, 1.08	0.023	1.03	1.01, 1.05	0.007
Factor VIII (per SD=67)	1.00	0.97, 1.03	0.909	1.03	1.01, 1.05	0.002

(all variables were entered into the model simultaneously)

BMI = body mass index; CAC = coronary artery calcium; CRP = C reactive protein; DTAC = descending thoracic aortic calcification; HDL = high density lipoprotein; LDL = low density lipoprotein; SD = standard deviation

Table 4

Association of presence/absence of Coronary Calcium with Descending thoracic calcification in relative risk regression.

	Unadjusted Prevalence Ratio (95% CI)	Fully Adjusted* Prevalence Ratio (95% CI)
DTAC status		
DTAC=0	1.00 (ref)	1.00 (ref)
DTAC>0	1.39 (1.26, 1.53) [†]	1.17 (1.07, 1.28) [†]
Continuous DTAC		
Ln(DTAC+1)	1.07 (1.06, 1.08) [†]	1.02 (1.01, 1.03) [†]

* adjusted for age, gender, race, smoking, hypertension, Diabetes, Family History of Heart Disease, LDL, HDL, lipid lowering medications, interleukin-6, fibrinogen, Factor VIII, body mass index. DTAC = descending thoracic aortic calcification

[†]
p<0.05

Table 5
Association of Descending Thoracic calcification and coronary calcium stratified by gender.

	Women			Men		
	Prevalence Ratio	95% CI	p-value	Prevalence Ratio	95% CI	p-value
Unadjusted						
DTAC=0	1.00 (ref)	--	--	1.00 (ref)	--	--
DTAC>0	1.43	1.22, 1.67	<0.001	1.42	1.28, 1.57	<0.001
Ln(DTAC+1)	1.11	1.09, 1.14	<0.001	1.03	1.02, 1.05	<0.001
Fully adjusted*						
DTAC=0	1.00 (ref)	--	--	1.00 (ref)	--	--
DTAC>0	1.26	1.08, 1.47	0.003	1.19	1.07, 1.32	0.001
Ln(DTAC+1)	1.04	1.02, 1.06	<0.001	0.99	0.98, 1.01	0.430

* adjusted for age, gender, race, smoking, hypertension, Diabetes, Family History of Heart Disease, LDL, HDL, lipid lowering medications, interleukin-6, fibrinogen, Factor VIII, body mass index.
PR=prevalence Ratio; DTAC = descending thoracic aortic calcification