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Research paper

Association between aortic valve calcification measured on non-contrast computed tomography and aortic valve stenosis in the general population

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ABSTRACT

Background: Aortic valve calcification (AVC) measured on non-contrast computed tomography (CT) has shown correlation to severity of aortic valve stenosis (AS) and mortality in patients with known AS. The aim of this study was to determine the association of CT verified AVC and subclinical AS in a general population undergoing CT.

Methods: CT scans from 566 randomly selected male participants (age 65–74) in the Danish cardiovascular screening study (DANCAVAS) were analyzed for AVC. All participants with a moderately or severely increased AVC score (≥300 arbitrary units (AU)) and a matched control group were invited for a supplementary echocardiography. AS was graded by indexed aortic valve area (AVAi) on echocardiography as moderate 0.6–0.85 cm^2/m^2 and severe < 0.6 cm^2/m^2, respectively. ROC- and regression analyses were performed.

Results: Due to prior valve surgery, and artifacts from ICD leads 16 individuals were excluded from the AVC scoring. Moderate or severe increased AVC was observed in 10.7% (95% CI: 8.4–13.7). Echocardiography was performed in 101 individuals; 32.7% (95% CI: 21.8 to 46.0) with moderate or high AVC score had moderate or severe AS, while none with no or low AVC. A ROC analysis defined an AVC score ≥588 AU to be suggestive of moderate or severe AS (AUC 0.89 ± 0.04, sensitivity 83% and specificity 87%). In the univariate analyses, AVC was the only variable significantly associated with AS.

Conclusions: This study indicates an association between CT verified AVC and subclinical AS.

1. Introduction

Calcific aortic valve stenosis (AS) is the most common heart valve disease in the western world with a prevalence ranging from 2 to 7%.[1,2] AS is a progressive disease with calcification or even active bone formation in the cusps. In asymptomatic AS, the severity of aortic valve calcification (AVC) assessed by echocardiography is able to detect a subset of patients at increased risk. As a consequence it has been proposed that low risk patients with severe AVC should be considered for early AVR even before the development of symptoms.[3] Recently, AVC scores have been developed for cardiac-CT. Although these scores have shown to correlate with the grade of AS in patients with already established valvular disease,[4] the impact of elevated AVC score in the general population is less evident. The purpose of our study was to explore the association between AVC and aortic valve disease in a general population of 65–74 years old men.

2. Methods

2.1. Study population

The DANish CArdioVAscular Screening study (DANCAVAS) is an

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ongoing randomized clinically controlled multicenter screening and intervention trial.[5] The primary objective of the DANCAVAS study is to establish the effect and cost-effectiveness of an extensive cardiovascular screening and intervention program for males aged 65–74 years in a randomized, clinically controlled set up. The first 566 randomly selected participants in the DANCAVAS study were enrolled in this substudy with AVC scoring on the existing non-contrast CT scans. All subjects with moderate to high levels of AVC were invited to a supplementary echocardiography, in addition to 45 matched controls (Fig. 1). The study was approved by the Regional Scientific Ethical Committees for Southern Denmark (Project ID: S-20140028). Informed consent was obtained for all participants.

2.2. Baseline measures

Before examination participants completed a questionnaire concerning medical conditions, current medication, smoking habits and symptoms (exertional shortness of breath, palpitations, chest pain and syncope). Upon examination, weight and height were measured, and body mass index (BMI) and body surface area (BSA) were calculated. Auscultation was not performed.

2.3. Computed tomography

A Siemens Somatom Definition Flash 128-slice Dual Source scanner was used with the following settings: Gantry rotation time 0.28 s, 3.0 mm collimation, acquisition 128 × 0.6 mm, 120 kV tube voltage, 90 mA tube current, and a prospectively ECG-triggered scan (gating at 35% or 70% of the R–R interval, depending on the heart rate, above below or 70, respectively). A technical feature (temporal resolution of 75 ms) made it possible to visualize high quality images for participants with high/irregular heart rate.

2.4. AVC scoring

AVC scoring were performed off-line on a dedicated computer (Syngo.via, Siemens Healthcare, Forchheim, Germany) using the Agatston method,[6] and expressed in arbitrary units (AU). Precise AVC scoring is hampered on non-contrast CT scans, thus using the axial slices, we defined AVC as calcification within the valve leaflet, in the aortic sinus of Valsalva (starting 6 mm below the ostium of the coronaries), or in the aortic annulus (Fig. 2). Calcifications in the coronaries and mitral valve annulus were excluded. The valve calcification score was performed by summing-up all spots of calcifications in the aortic valve areas. The AVC was arbitrary classified as no (score 0), low (score 1–299), moderate (300–499) or high (≥500). Intra-observer variation variability was tested by re-analyzing 60 CT-scans. The scans were analyzed blinded for clinical data. Intra-observer variability for AVC scoring was 0.998 (95% CI; 0.997–0.999) (Lin's Concordance Correlation Coefficient).

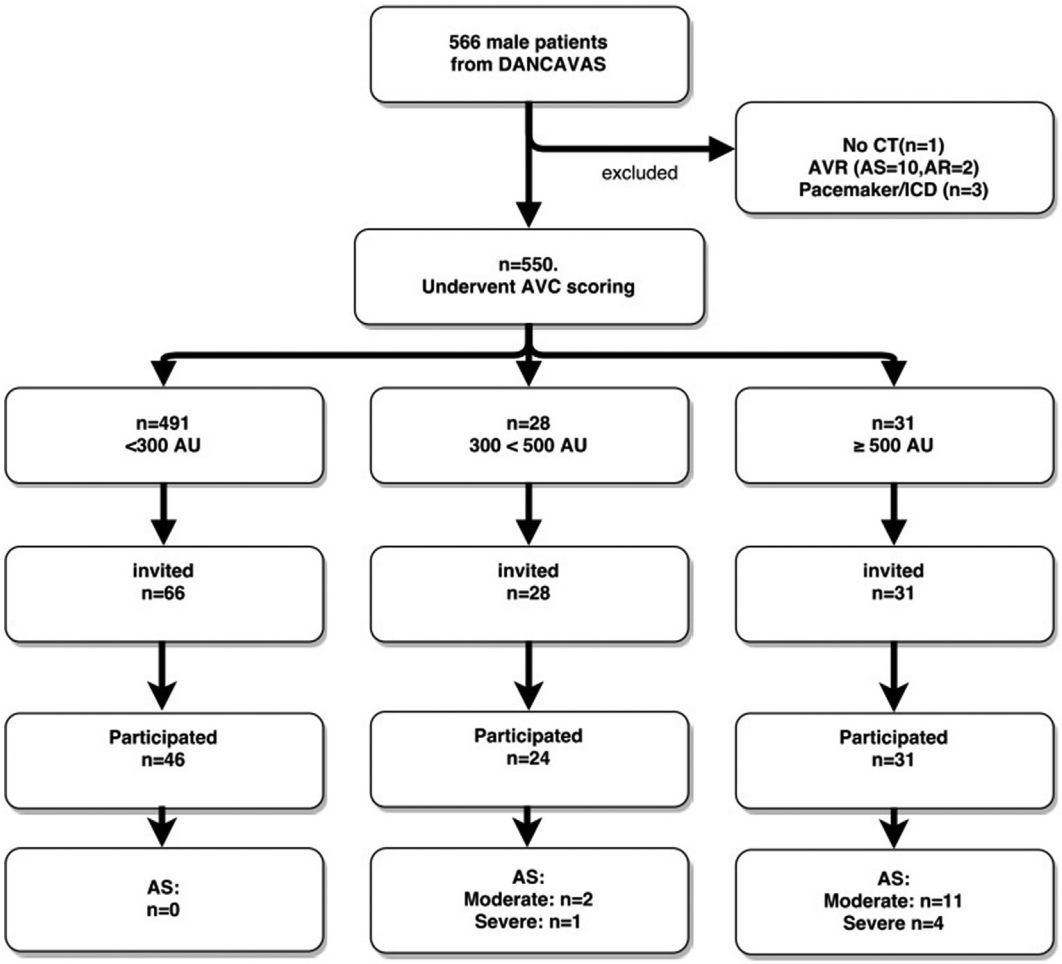

Fig. 1. Flowchart for all participants. CT = Computed tomography, AVR = Aortic valve replacement, AS = Aortic stenosis, AR = Aortic regurgitation, ICD = Implantable cardioverter-defibrillator, AVC = Aortic valve calcification, AU = Arbitrary units, AS = Aortic stenosis, moderate = 0.60–0.85 cm^2/m^2 and severe ≤0.6 cm^2/m^2.