Cardiovascular Risk Factors and Thoracic Aortic Wall Thickness in a General Population

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ABSTRACT

Purpose: To evaluate the association of cardiovascular risk factors with wall thickness of the ascending and descending thoracic aorta in the general population.

Materials and Methods: The study included 1,176 individuals (523 women) 21–83 years old from the Study of Health in Pomerania without history of stroke or myocardial infarction. Aortic wall thickness (AWT) was determined by cine magnetic resonance imaging. The associations of AWT with the cardiovascular risk factors male sex, age, smoking, body mass index (BMI), systolic and diastolic blood pressure, hemoglobin A_{1c}, high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and triglycerides were assessed by multivariable linear regression models, and interaction effects were tested.

Results: Male sex ($\beta = .086$, $P < .001$), age ($\beta = .006$, $P < .001$), and BMI ($\beta = .013$, $P < .001$) were positively associated with the AWT of the ascending aorta. Male sex ($\beta = .105$, $P < .001$), age ($\beta = .006$, $P < .001$), current smoker ($\beta = .044$, $P = .010$), BMI ($\beta = .013$, $P < .001$), and HDL-C ($\beta = .057$, $P = .008$) revealed a positive association with AWT of the descending aorta. LDL-C ($\beta = -.024$, $P = .009$; $\beta = -.018$, $P = .010$) was inversely associated with the AWT of the ascending and descending aorta, respectively. Triglyceride levels ($\beta = .024$, $P = .027$; $\beta = .018$, $P = .024$) showed a positive association with the AWT of the ascending and descending aorta, respectively, in men, but not in women.

Conclusions: Established cardiovascular risk factors, including male sex, older age, smoking, high BMI, and high triglyceride levels, were associated with increasing thoracic AWT of the ascending and descending aorta. High HDL-C and low LDL-C levels were correlated with AWT.

ABBREVIATIONS

AWT = aortic wall thickness, BMI = body mass index, CI = confidence interval, HbA_{1c} = hemoglobin A_{1c}, HDL-C = high-density lipoprotein cholesterol, LDL-C = low-density lipoprotein cholesterol, SHIP = Study of Health in Pomerania

Atherosclerotic cardiovascular diseases account for much morbidity and mortality in developed countries (1,2). Increased wall thickness of the common carotid artery can be regarded as a surrogate parameter of atherosclerosis and predicts cardiovascular events including myocardial infarction, stroke, and cardiovascular mortality (3,4). Established cardiovascular risk factors such as age, male gender, smoking status, and hypertension show significant associations with the wall thickness of the common carotid artery (5,6).

Studies investigating thoracic aortic wall thickness (AWT) are rare mainly because it is more difficult to identify the aortic wall by ultrasound. Magnetic resonance (MR) imaging is a noninvasive and feasible alternative method to measure the AWT (7).

Several cardiovascular risk factors are known to be associated with AWT as determined by MR imaging (7–9). In the Dallas Heart Study, Rosero et al (9) found

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significant associations of greater abdominal AWT with older age, male gender, smoking status, higher systolic blood pressure, higher low-density lipoprotein cholesterol (LDL-C) and lower high-density lipoprotein cholesterol (HDL-C) levels, and higher blood glucose levels. The results regarding age, sex, and systolic blood pressure confirm the results of Malayeri et al (8) and Li et al (7) investigating the thoracic AWT in the Multiethnic Study of Atherosclerosis.

Cardiovascular risk factors of the thoracic AWT in a general population have been assessed only for the descending aorta for selected parameters but not for the ascending aorta (7,8). After assessing reference values for thoracic AWT in the same population (10), the present study was conducted to evaluate the associations of several cardiovascular risk factors with valid and reliable AWT measurements (11) of the thoracic ascending and descending aorta determined by highly standardized MR imaging examination (12) in the population-based Study of Health in Pomerania (SHIP).

MATERIALS AND METHODS

Study Sample

This study was approved by the Ethics Committee of the University of Greifswald and complies with the Declaration of Helsinki. All participants provided written informed consent. SHIP is a population-based project consisting of two cohorts established in the northeast area of Germany. Baseline recruitment of the first cohort (SHIP-0) was conducted between 1997 and 2001 (including 4,308 subjects, age range, 20–79 y) (13). SHIP-2 is the second follow-up of the first cohort and was conducted between 2008 and 2012 (including 2,333 subjects). In parallel, a second independent cohort (SHIP-TREND) was studied between 2008 and 2012 (including 4,420 subjects, age 20–79 y) (10).

During the period from 2008 to 2012, 1,507 subjects from the two cohorts were examined by cardiovascular MR imaging. For the present analyses, we excluded subjects with insufficient imaging quality (n = 281) and with implausible values for calculated AWT (n = 9). We further excluded subjects with a history of stroke (n = 18), myocardial infarction (n = 15), and missing data for potential cardiovascular risk factors (n = 8). The final study sample comprised 747 subjects (308 women) 21–81 years old for SHIP-TREND and 429 subjects (215 women) 31–83 years old for SHIP-2.

Risk Factor Measurements

Data on age and sex were provided by the population registries. Standardized personal interviews were used to collect information regarding smoking status (categorized as never smoker, ex-smoker, or current smoker), history of stroke, myocardial infarction, and diabetes. For the definition of current diabetes, a self-reported physician's diagnosis or hemoglobin A_{1c} (HbA_{1c}) value $\geq$ 6.5% was used (14).

Waist circumference was measured horizontally with an inelastic tape in the middle between the lower rib margin and the iliac crest. Body mass index (BMI) was calculated as weight (kg) divided by the square of height (m^2).

Systolic and diastolic blood pressures were measured three times at the right arm of seated subjects using a digital blood pressure monitor (HEM-705CP; OMRON Corp, Tokyo, Japan) after a 5-minute rest period, with each reading being followed by another rest period of 3 minutes. The mean of the second and third measurements was calculated and used for the present analyses. Hypertension was defined as increased systolic blood pressure ($\geq$140 mm Hg), increased diastolic blood pressure ($\geq$90 mm Hg), or self-reported use of antihypertensive medication.

Blood samples were drawn from the median antecubital vein in the supine position. The samples were taken between 7:00 AM and 4:00 PM and analyzed immediately. Serum HbA_{1c} levels were measured by high-performance liquid chromatography (Bio-Rad Diamat Analyzer, ClinRep kit; RECIPE Chemicals+Instruments GmbH, Munich, Germany). LDL-C, HDL-C, and triglyceride levels were determined enzymatically using reagents from Dade Behring (Dimension Vista System, Flex reagent cartridge; Dade Behring Ltd, Milton Keynes, United Kingdom).

MR Imaging Examination and AWT Measurements

MR imaging was performed on a 1.5-tesla scanner (MAGNETOM Avanto; Siemens Healthcare, Erlangen, Germany). Integrated coil elements and phased-array surface coils were used for data acquisition. AWT values were measured by two observers independently at the level of the right pulmonary artery using OsiriX software (version 3.6.1; Pixmeo Sarl, Bernex, Switzerland). A two-dimensional cine steady-state free precession sequence (field of view, 360 mm × 293 mm; matrix, 208 × 256; slice thickness, 6 mm; repetition time/echo time, 5.62/1.18; flip angle, 68°) was used for AWT calculations. To ensure better comparability and to reduce motion artifacts of the aorta, the image with a trigger time closest to 600 ms was chosen. For optimal reading image zoom (200%–300%), contrast and brightness were adjusted. Two regions of interest were placed manually including the internal and external aortic wall of the ascending aorta. The radius of each area was calculated, assuming that all areas are circular (10,11). AWT was calculated as the difference in the radii of the external and internal aortic area (15).

Statistical Analyses

Descriptions of potential cardiovascular risk factors and AWT of the two cohorts SHIP-TREND and SHIP-2 are