CLINICAL RESEARCH STUDY

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Visualization of Coronary Artery Calcification: Influence on Risk Modification

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ABSTRACT

OBJECTIVES: Direct health provider to patient presentation of coronary computed tomography angiography findings may increase adherence to preventive therapy and risk modification. The purpose of this study was to assess the influence of visualization of coronary artery calcification and lifestyle recommendations on cholesterol concentrations and other risk variables in symptomatic patients with nonobstructive coronary artery disease and hyperlipidemia.

METHODS: We performed a prospective 2-center randomized controlled trial. Patients were randomized 1:1 to intervention or standard follow-up in general practice. The primary end point was change in plasma total cholesterol concentration at 6 months follow-up.

RESULTS: We included 189 patients (mean [± standard deviation] age 61 [12] years, 57% were male). Median (range) Agatston score was 166 (70-2054). The reduction in plasma total cholesterol concentrations tended to be higher in the intervention group than in the control group, 51.04 mg/dL versus 45.63 mg/dL ($P = .181$). In a subgroup including patients continuing statin therapy during follow-up (n = 147), the reduction in plasma total cholesterol concentrations was more pronounced in the intervention group than in the control group, 66.13 mg/dL versus 55.68 mg/dL ($P = .027$). In the intervention group, there was a higher degree of statin adherence and a higher proportion of patients who stopped smoking and commenced healthier dietary behavior than in the control group.

CONCLUSIONS: Visualization of coronary artery calcification and brief recommendations about risk modification after coronary computed tomography angiography in symptomatic patients with nonobstructive coronary artery disease and hyperlipidemia may have a favorable influence on plasma total cholesterol concentration, adherence to statin therapy, and risk behavior. Further investigations are needed.

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KEYWORDS: Adherence preventive therapy; Angina pectoris; Atherosclerosis; Coronary artery calcification; Lifestyle behavior; Risk factor modification

Modification of risk factors is pivotal in individuals with an elevated risk of coronary artery disease.[1,2] However, with knowledge about risk factors and information about risk reduction alone, persons with an elevated cardiovascular risk profile frequently are motivated inadequately for lifestyle changes and medicine adherence.[2-4] Coronary artery calcification is a marker of coronary atherosclerosis.[5] The degree of coronary artery calcification can be assessed by the Agatston score derived from nonenhanced cardiac computed tomography (CT),[6,7] whereas noninvasive CT imaging of the coronary arteries requires contrast enhancement (coronary CT angiography [CTA]).[7] The presence of coronary artery calcification is associated with an elevated probability of obstructive coronary artery disease and an

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unfavorable clinical outcome.[8,9] In observational studies of symptomatic patients, the presence of nonobstructive coronary artery disease at coronary CTA is associated positively with risk modification and intensified prophylactic medical treatment.[10,11] Also among asymptomatic individuals, those with the highest Agatston score levels seem to have the highest motivation for adoption of a risk-modifying behavior.[12] Thus, visualization of coronary artery calcification may stimulate adherence to lipid-lowering therapy, aspirin, and a healthier lifestyle.[13-16] The aim of the present prospective, randomized controlled study was to assess the influence of visualization of coronary artery calcification in addition to standard information about risk and lifestyle modification primarily on plasma cholesterol concentrations and other risk factors in patients with hyperlipidemia and a new diagnosis of nonobstructive coronary artery disease.

CLINICAL SIGNIFICANCE

- A structured nurse consultation, including visualization of coronary artery calcification and brief recommendations regarding risk behavior, in symptomatic patients with hyperlipidemia did not improve total cholesterol levels with statistical significance over a 6-month follow-up period.
- A structured nurse consultation, including visualization of coronary artery calcification and brief recommendations regarding risk behavior, may have a beneficial influence on statin adherence and risk behavior.
- Intensive and motivational-orientated consultations including visual displays of health threat may optimize individual risk management.

MATERIALS AND METHODS

Study Design and Patients

We conducted a 2-center prospective, randomized controlled study. Eligible patients were referred for coronary CTA with chest pain and a low to intermediate pretest likelihood of significant coronary artery disease. An Agatston score of 70 was used as the threshold for study inclusion. This threshold corresponds to the 75th percentile for Agatston score in a prestudy pilot cohort comprising 1479 consecutive patients with intermediate pretest likelihood of significant coronary artery disease who were referred for coronary CTA in 1 of the 2 study centers. The other inclusion criterion was hyperlipidemia defined as plasma total cholesterol concentration $\geq$193 mg/dL or plasma low-density lipoprotein (LDL) cholesterol concentration $\geq$116 mg/dL.[2,17] Exclusion criteria were contraindications to treatment with statins, statin use >3 months before inclusion, ongoing participation in a cardiac rehabilitation or lifestyle modification program, known coronary artery disease, acute coronary syndrome, heart failure, significant heart valve disease, and any apparent cognitive dysfunction or contraindications to coronary CTA (renal insufficiency, contrast allergy, extreme obesity, atrial fibrillation, pregnancy). All patients with stable chest pain referred for coronary CTA were screened consecutively for study enrollment between July 2010 and September 2012.

Symptoms were categorized as nonanginal chest pain, atypical angina, and typical angina as described by Diamond.[18] Depending on symptoms, age, and gender, the pretest likelihood of significant coronary artery disease was calculated to classify the patients into low-risk (<13.4%), intermediate-risk, or high-risk (>87.2%) groups.[19-21]

Coronary artery calcification was quantified by the Agatston score[6] (**Figure 1**). One center used the Siemens 64-slice dual-source CT scanner (Siemens Definition, Siemens Medical Solutions, Erlangen, Germany), and the other center used a Toshiba 64-slice CT scanner (Aquilion, Toshiba Medical Systems, Tokyo, Japan). Scan parameters were Gantry rotation time 300 to 450 ms, 3.0-mm slice thickness, 120 kV tube voltage, and prospective gating at 60% to 75% of the R-R interval. Patients underwent coronary CTA according to societal recommendations.[22] The decision regarding patients' referral for additional noninvasive ischemia testing or invasive coronary angiography was made at the discretion of the treating cardiologist and based on the symptoms, clinical examination, and coronary CTA result.

The Danish Data Protection Agency (J. no. 2010-41-4702) and the Regional Scientific Ethical Committee of Southern Denmark (S-201000032) approved the protocol. The study conforms to the principles of the Declaration of Helsinki.

Risk Factors

Cardiovascular risk factors included a family history of coronary artery disease, diabetes mellitus, smoking, body mass index (BMI) calculated as weight/height squared, blood pressure, plasma total cholesterol concentration, plasma LDL cholesterol concentration, and glycated hemoglobin (HbA1c).[17] A family history of coronary artery disease was defined as coronary artery disease at age <56 years and <66 years in first-degree relatives for men and women, respectively. Smoking was registered as never, previous, or current. No smoking was recommended. A BMI $\geq$25 kg/m^2 was defined as overweight. Avoidance of overweight was recommended. Hypertension was defined as a blood pressure $\geq$140/90 mm Hg or the use of antihypertensive medical treatment. The recommended blood pressure level was <140/90 mm Hg. Recommended plasma cholesterol concentrations were total cholesterol <193 mg/dL and LDL cholesterol <116 mg/dL. A threshold of 6.5% defined an elevated HbA1c value, and a value <6.5% was recommended.[2,17]