Prevalence of a minimal luminal cross sectional area of coronary arteries < 4 mm^2 determined by intravascular ultrasound in patients with coronary artery calcium scores of 0-100, 100-200, 200-300, 300-400, and > 400 determined by cardiac computer tomography

John H. Shao, Wilbert S. Aronow, Gautham Ravipati, Kumar Kalapatapu, Melvin B. Weiss, Albert J. DeLuca, Craig E. Monsen, Carmen Sorbera, Robert N. Belkin, Anthony L. Pucillo

Department of Medicine, Division of Cardiology, New York Medical College, Valhalla, NY, USA

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Address for correspondence:
Wilbert S. Aronow, MD
Cardiology Division
New York Medical College
Macy Pavilion, Room 138
Valhalla, NY 10595
Phone: (914) 493-5311
Fax: (914) 235-6274
E-mail: wsaronow@aol.com

Abstract

Introduction: The prevalence of a minimal luminal cross sectional area (MLCSA) of coronary arteries < 4 mm^2 determined by intravascular ultrasound (IVUS) in patients with coronary artery calcium (CAC) scores determined by computer tomography (CT) needed investigation.

Material and methods: We investigated the prevalence of a MLCSA of coronary arteries < 4 mm^2 determined by IVUS in patients with CAC scores of 0-100, 100-200, 200-300, 300-400, and > 400 determined by CT. The 25 patients included 16 men and 9 women, mean age 60 ±8 years, who had IVUS measurements of MLCSA of coronary artery lesions and of CAC score from the same coronary artery. A MLCSA of coronary arteries < 4 mm^2 determined by IVUS was considered significant coronary artery obstruction. A CAC score of 0-100 was considered mild coronary artery disease (CAD), of 100-400 moderate CAD, and of > 400 severe CAD.

Results: The mean MLCSA was 5.2 mm^2 in patients with CAC scores of 0-100, 4.7 mm^2 in patients with CAC scores of 100-200, 4.2 mm^2 in patients with CAC scores of 200-300, 5.6 mm^2 in patients with CAC scores of 300-400, and 3.8 mm^2 in patients with CAC scores of > 400 (p not significant). A MLCSA < 4 mm^2 was present in 3 of 6 patients (50%) with CAC scores of 0-100, in 3 of 6 patients (50%) with CAC scores of 100-200, in 2 of 4 patients (50%) with CAC scores of 200-300, in 0 of 3 patients (0%) with CAC scores of 300-400, and in 4 of 6 patients (67%) with CAC scores > 400 (p not significant).

Conclusions: These data indicate that CAC scores determined by CT do not accurately predict significant obstructive CAD determined by IVUS.

Key words: intravascular ultrasound, coronary artery disease, coronary artery calcium score.

Introduction

Intravascular ultrasound is considered the reference standard for detection of atherosclerotic plaques [1, 2]. Electron beam computed tomography (CT) is a noninvasive test that helps to visualize coronary

atherosclerosis by localization and quantitation of coronary artery calcification (CAC) [3, 4]. The present prospective study compares in 25 patients who had both CT and intravascular ultrasound (IVUS) the accuracy of CAC scores in predicting a minimal luminal cross sectional area of a coronary artery < 4 mm^2 [5].

Material and methods

A prospective study was performed in 25 patients (16 men and 9 women), mean age 60 ±8 years, who had IVUS measurements of minimal luminal cross sectional area of coronary artery lesions in patients who had measurements of CAC score for the same coronary artery. The left anterior descending coronary artery was investigated in 18 patients (72%), the left main coronary artery in 3 patients (12%), the right coronary artery in 2 patients (8%), the left circumflex coronary artery in 1 patient (4%), and the first diagonal coronary artery in 1 patient (4%). Intravascular ultrasound was performed as previously described [5]. A MLCSA of coronary arteries < 4 mm^2 determined by IVUS was considered the gold standard for significant coronary artery obstruction [5].

The IVUS system used was manufactured in the United States (Boston Scientific Corp., Natick, MA). 40-MHz coronary catheters with 2.5 F at the tip and 3.2 F at the largest dimension, compatible with a 6 F guiding catheter were used. The catheters were advanced over a regular guide wire, usually 0.36 mm (0.014") in diameter, using a short rail section at the catheter tip, just beyond the 15-cm-long segment within which the spinning transducer can be advanced or withdrawn. The ultrasound catheter tip was slid in over the guidewire and positioned so that the tip was at the farthest away position to be imaged. The sound waves were emitted from the catheter tip, and the catheter also receives and conducts the return echo information out to the external computerized ultrasound equipment which constructs and displays a real time ultrasound image of a thin section of the blood vessel currently surrounding the catheter tip, usually displayed at 30 frames/second image. The guide wire was kept stationary, and the ultrasound catheter tip was slid backwards, usually under motorized control at a pullback speed of 0.5 mm/s.

Scans for CAC scoring were obtained using a Siemens Somatom Sensation Cardiac computed tomography (CT) system (Siemens AG Medical Solutions, Erlangen, Germany). Calcium scoring was performed as a component of a complete cardiac CT study that included 64 slice coronary CT angiography, or as a stand alone procedure in patients referred for calcium scoring alone. Calcium scans were performed using a spiral scanning protocol (rotation time 0.33 ms, slice collimation 0.6 mm, slice width 3.0 mm, pitch factor 0.2, increment of 1.5 mm, kernel B35) or using a sequential scanning protocol with ECG triggering (rotation time 0.33 ms, slice collimation 0.6 mm, slice width 3.0 mm, kernel B35). Calcium scoring was performed by one of two cardiologists experienced in cardiac CT, employing a TeraRecon Aquarius workstation (TeraRecon, San Mateo, California). A CAC score of 0-100 was considered mild coronary artery disease (CAD), of 100-400 moderate CAD, and of > 400 severe CAD [6].

The cardiologists who made the IVUS measurements were unaware of the CAC scores. The cardiologists who made the CAC score measurements were unaware of the IVUS measurements.

Student's *t* tests were used to analyze continuous variables. Chi-square tests were used to analyze dichotomous variables. An analysis of variance test was performed.

Results

Of the 25 patients, 6 (24%) had a CAC score of 0-100, 13 (52%) had a CAC score of 100-400, and 6 (24%) had a CAC score of > 400. Of the 25 patients, 12 (48%) had a minimal luminal cross sectional area of the coronary arteries investigated by IVUS of < 4 mm^2. Percutaneous coronary intervention with stenting was performed in 12 of 12 patients (100%) with a minimal luminal cross sectional area of < 4 mm^2 and in none of 13 patients (0%) with a minimal luminal cross sectional area of > 4 mm^2.

Table I shows the mean minimal luminal cross sectional area of the coronary arteries visualized by IVUS in patients with CAC scores of 0-100, 100-200, 200-300, 300-400, and > 400. No significant differences were found.

Table I. Mean minimal luminal cross sectional area of coronary arteries determined by intravascular ultrasound in patients with coronary artery calcium scores of 0-100, 100-200, 200-300, 300-400, and > 400 determined by computer tomography

Coronary artery calcium score	Mean luminal cross sectional area [mm^2]
0-100[1] (*n* = 6)	5.2 ±3.0
100-200[2] (*n* = 6)	4.7 ±2.3
200-300[3] (*n* = 4)	4.2 ±1.9
300-400[4] (*n* = 3)	5.6 ±1.0
> 400[5] (*n* = 6)	3.8 ±1.3

No significant differences are found comparing 2 with 1, 3 with 1, 4 with 1, and 5 with 1

Table II. Prevalence of a minimal luminal cross sectional area of coronary arteries less than 4 mm^2 determined by intravascular ultrasound in patients with coronary artery calcium scores of 0-100, 100-200, 200-300, 300-400, and > 400 determined by computer tomography

Coronary artery calcium scores	Minimal luminal cross sectional area < 4 mm^2
0-100	3/6 (50%)
100-200	3/6 (50%)
200-300	2/4 (50%)
300-400	0/3 (0%)
> 400	4/6 (67%)

No significant differences are present

Table II shows the prevalence of a minimal luminal cross sectional area of the coronary arteries visualized by IVUS of < 4 mm^2 n patients with CAC scores of 0-100, 100-200, 200-300, 300-400, and > 400. No significant differences were found using the χ^2 test and the analysis of variance test.

Discussion

A good correlation was observed between calcium quantification by CT and by IVUS [7]. Computed tomography density values measured within plaques by CT in 37 patients who also had IVUS reflect echogenity and plaque composition [8].

However, to the best of our knowledge, no study has been reported showing the mean minimal luminal cross sectional area of the coronary arteries visualized by IVUS in patients with CAC scores of 0-100, 100-200, 200-300, 300-400, and > 400. To the best of our knowledge, no study has also reported the prevalence of a minimal luminal cross sectional area of the coronary arteries visualized by IVUS of < 4 mm^2 in patients with CAC scores of 0-100, 100-200, 200-300, 300-400, and > 400.

The present prospective IVUS study showed that the mean mean minimal luminal cross sectional area of the coronary arteries visualized by IVUS was not significantly different in patients with CAC scores of 0-100, 100-200, 200-300, 300-400, and > 400. The present study also showed that the prevalence of a minimal luminal cross sectional area of the coronary arteries visualized by IVUS of < 4 mm^2 was not significantly different in patients with CAC scores of 0-100, 100-200, 200-300, 300-400, and > 400. These data indicate that CAC scores determined by CT do not accurately predict significant obstructive CAD diagnosed by IVUS. Therefore, CAC scores cannot be used in clinical practice to predict significant obstructive CAD [9, 10] diagnosed by IVUS.

Acknowledgments

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