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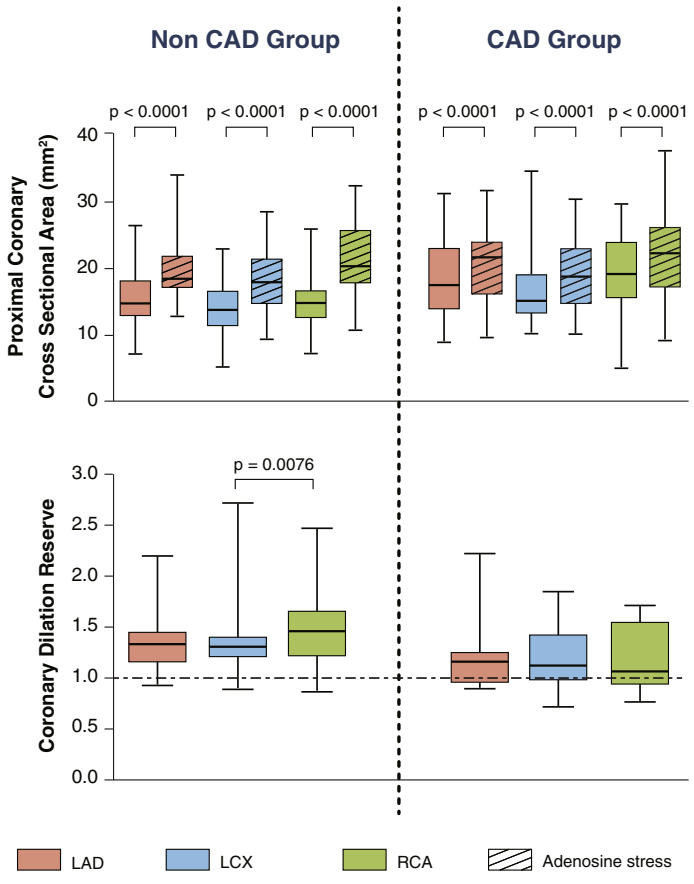
Functional Impact of Atherosclerosis on Epicardial Coronary Conductance Vessels Assessed With MDCT

It is currently unclear to what extent differences in the ability to dilate the epicardial conductance vessels are linked to presence and degree of coronary atherosclerosis. Cardiac multidetector computed tomography (MDCT) technology offers the opportunity to assess epicardial coronary vessel area changes in response to adenosine, as well as coronary atherosclerosis. We tested the hypothesis that the presence and extent of coronary atherosclerosis are associated with proportionate abnormalities of epicardial vasodilatory capacity.

FIGURE 1 Epicardial Coronary Vasodilation



(Top) Proximal coronary cross-sectional area at rest and with adenosine vasodilation (hatched) in the left anterior descending artery (LAD), left circumflex artery (LCX), and right coronary artery (RCA) in the group without coronary artery disease (non-CAD group) and the CAD group. **(Bottom)** Coronary dilation reserve in the non-CAD group and the CAD group for LAD, LCX, and RCA.

We studied patients from the CATCH (CArdiac cT in the treatment of acute CHest pain) trial (1): 41 patients without coronary atherosclerosis determined by MDCT and with no history of diabetes mellitus or hypertension (non-CAD [coronary artery disease] group) and 27 patients with at least 1 significant epicardial coronary artery stenosis (>70% stenosis; the CAD group). All patients had been hospitalized for acute chest pain within 2 weeks but had been discharged after normal serial electrocardiograms and troponin levels. An oral cardioselective beta blocker was given for heart rate control before the MDCT (Aquilion One, Toshiba Medical Systems, Tokyo, Japan). Proximal coronary cross-sectional area (pCCSA) was measured in the left anterior descending artery, the left circumflex artery, and the right coronary artery. The proximal 10 mm was traced in each vessel during rest and adenosine vasodilation, and the mean coronary cross-sectional area of the 10 mm was defined as pCCSA and normalized to body surface area (BSA) (pCCSA × [standard BSA/measured BSA]). In patients in whom all vessels could be assessed both at rest and during adenosine vasodilation, global pCCSA was calculated as the average of the 3 proximal volume measures in each patient. Epicardial coronary dilatory reserve (CDR) was calculated as adenosine vasodilation pCCSA divided by rest pCCSA.

Significant CAD was confirmed invasively according to the main CATCH study protocol in 22 CAD patients (81%). CAD patients were older and more obese and more frequently had hyperlipidemia than non-CAD patients. Heart rate during adenosine vasodilation increased by approximately 20% in both groups.

In interobserver and intraobserver measurements of pCCSA, the range of the Pearson coefficient was high (interobserver: 0.77 to 0.97 for rest and 0.50 to 0.87 for adenosine vasodilation; intraobserver: 0.83 to 0.90 for rest and 0.88 to 0.95 for adenosine vasodilation). pCCSA increased in all vessels during adenosine vasodilation compared with rest in both study groups (Figure 1). The dilatory capacity of coronary vessels in the non-CAD group was approximately 40%, whereas it was only 12% in the CAD group. Within the non-CAD group, CDR of the right coronary artery was higher than that of the left circumflex artery and tended to be higher than that of the left anterior descending artery ($p = 0.07$). CDR of each vessel was lower in CAD patients than in the corresponding vessels in non-CAD patients. In the CAD group, no correlation between severity of coronary stenosis and CDR of the corresponding vessel was found.

Global pCCSA at rest was higher in the CAD group than in the non-CAD group, and no relationship was

found between pCCSA at rest and the presence of cardiovascular risk factors or medical treatment in either of the groups. During adenosine vasodilation, global pCCSA was not significantly different between the groups, and consequently, global CDR was significantly lower in the CAD group than in the non-CAD group (1.18 ± 0.21 vs. 1.43 ± 0.23; p = 0.0003). In both groups, no relationship was found between age, sex, body mass index, hypercholesterolemia, ischemic heart disease in family, or smoking habits and global CDR. Furthermore, in the CAD group, no relationship was found between coronary Agatston score and global CDR.

In this study, we demonstrated that the presence of CAD was associated with a severe impairment of epicardial coronary vasodilatory capacity not related to the degree of coronary artery stenosis or vascular calcification. Impairment of vasodilatory capacity in patients with atherosclerosis appeared to be the consequence of increased coronary vascular size at rest, without a proportionate increase in vessel size during adenosine vasodilation. Because adenosine vasodilation is associated with increased heart rate, effective spatial resolution of MDCT could be reduced, and our results should be interpreted accordingly. However, only the largest and less mobile segments of the coronary vascular tree, the proximal portions, were assessed.

We conclude that the presence of atherosclerosis in epicardial conductance vessels is associated with an impairment of proximal vasodilatory capacity in coronary vessels of the heart, not related to the degree of coronary artery stenosis.

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Lack of Stroke Volume Determined Flow Reserve Does Not Always Preclude Assessment of Severity of Aortic Stenosis in Low-Flow Low-Gradient State During Dobutamine Echocardiography

The severity of low-flow low-gradient (LFLG) aortic stenosis (AS) during low-dose dobutamine stress echocardiography (LDDSE) is deemed assessable only when stroke volume–determined flow reserve (SVFR) (stroke volume [SV] increase ≥20%) is present. However, due to typically frequently exponential increase in heart rate (HR) and the consequent drop in left ventricular (LV) filling time, the SV during LDDSE often drops (1). However, despite lack of SVFR, the transvalvular flow or flow rate (FR) (SV/ejection time) may increase because, with rising HR, ejection time may shorten sufficiently to normalize FR, at which juncture the observed gradient and aortic valve area (AVA) will reflect the true status of AS (2). We thus hypothesized that during LDDSE for the assessment of LFLG AS, even in the absence of SVFR, FR may normalize, which will allow assessment of true severity of AS. FR ≥200 ml/s was considered normal (3,4).

We retrospectively assessed 42 consecutive patients (mean age 75.6 years) with LFLG AS (AVA <1 cm^2, mean gradient [MG] <40 mm Hg) who underwent LDDSE of which 33 (79%) demonstrated left ventricular ejection fraction (LVEF) <50%. Dobutamine was infused at 5, 10, 15, and up to 20 μg/kg/min with 5-min increments, and SV, FR, MG, and AVA were assessed at each stage. True severe aortic stenosis (TSAS) was defined as AVA <1 cm^2 and MG ≥40 mm Hg during LDDSE. For the comparisons of continuous and categorical variables, the independent Student *t* test and the chi-square/McNemar tests were used. Correlation between continuous variables was assessed by Pearson test.

The changes in HR between patients with SVFR and those without were similar (21 ± 16 beats/min vs. 24 ± 23 beats/min; p = 0.6) and showed similar results