Editorial Commentary

Relevance of Screening Symptom-Free Population for Coronary and Noncoronary Calcification Burden

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Early detection of arterial disease in the preclinical stage may improve cardiovascular disease sequelae, such as myocardial infarction and stroke. At present, the optimal imaging technique to detect subclinical arterial disease has not been determined. Calcium-based imaging by noncontrast computed tomography (CT) is widely used to detect noninvasively coronary calcification, an established surrogate of coronary atherosclerosis.

In this issue of Hypertension, Jensky et al performed “whole body” noncontrast CT imaging of the arterial tree from the skull to the pubic symphysis in a large free-living, middle-aged, and mostly asymptomatic population to detect calcium deposit not only within the coronary bed but also in several noncoronary territories, including carotid, subclavian, and iliac arteries and the thoracic and abdominal aorta. The prevalence of any calcification ranged from 32% in the carotid and subclavian arteries to 57% in the coronary arteries.

Other than expected associations of arterial calcium with aging, male sex, smoking, dyslipidemia, and diabetes mellitus, calcification was strongly and independently associated with hypertension in all of the vascular beds except the distal iliac and subclavian arteries. Association of calcification and hypertension was stronger in older than in younger subjects and in men than in women, and its magnitude was greater when pulsatile components of hypertension, that is, pulse and systolic pressures, were considered.

Beyond the demonstration of the close link of hypertension, especially its isolated systolic type, with calcium deposit in most vascular beds, the work of Jensky et al raises 3 important issues: (1) the value and specificity of CT-assessed calcification for the measurement of arterial disease; (2) the mechanisms by which hypertension may promote arterial calcification; and (3) the prognostic relevance of exhaustive detection of calcification in coronary and noncoronary territories.

The first issue is subordinated to the equivocal nature of vascular calcification that has to be divided into 2 distinct entities according to its specific site within the artery wall: calcification of the intima in the vicinity of lipid or cholesterol deposits as is present in plaque calcification and calcification of the media in the absence of such lipid or cholesterol deposits, often referred to as “mediacalcosis.” The 2 types of calcification may vary according to large elastic versus a smaller muscular-type artery and proximal versus distal sites of the arterial tree. Thus, calcification in the coronary bed, which affects intima almost exclusively, is a pathognomonic marker of calcified atherosclerosis. In contrast, calcification in extracoronary arteries that can be deposited in the media and/or the intima is an ambiguous and nonspecific marker of atherosclerosis and/or mediacalcosis. Therefore, noncontrast CT that does not allow for distinguishing between intimal and medial calcification in the artery wall can accurately track atherosclerosis only in the coronary bed but not in noncoronary vessels, which constitutes a limitation to its clinical applicability to imaging of the whole arterial tree.

A second issue raised by the findings of Jensky et al is whether mechanisms related to hypertension may be shared by intimal and medial calcification that may occur in conjunction or in isolation depending on the vascular bed. Intimal calcification or calcified atherosclerosis is promoted by cardiovascular risk factors, including hypertension, whereas a calcium deposit in the media is mainly governed by biomechanical interactions between hypertension and elastic properties of the artery wall. Indeed, the pulsatile components of hypertension, pulse pressure, and systolic pressure chronically provoke the fatigue of bioelastomers that may result in elastocalcosis. Conversely, medial calcification stiffens the artery wall, decreases its buffering function, and results in increased pulse and systolic pressures that may lead to isolated systolic hypertension. Although it is unclear whether systolic hypertension is an independent cause or a consequence of wall calcium deposit in the media, it is plausible that both phenomena are present and linked by a vicious circle. Moreover, other hypertension-related factors, more or less specific to intimal and/or medial calcification, may be operative, such as increased oxidative stress and inflammation. Thus, it has been shown in hemodialysis patients for whom C-reactive protein is a significant predictor of both intimal and medial calcification in the aorta and peripheral arteries. Also, increased plasma fibrinogen predicts coronary calcium deposit in asymptomatic hypercholesterolemic subjects. Lastly, disturbances in calcium and phosphorus metabolism that are important in the development of vascular calcification in chronic kidney disease may play a role in the promotion of arterial calcification by hypertension via early hypertensive renal damage.
The prognostic information provided by arterial calcification detection in multiple vascular beds is the most important issue, from a clinical point of view, raised by the work of Jensky et al and obviously depends of the intimal or medial site of calcium deposit. Intimal or plaque calcification has the prognostic significance of atherosclerotic disease, although its consequences on plaque vulnerability and occlusive arterial disease may be different from that of noncalcified plaque. Calcification of the media layer has no flow-limiting consequence but causes arterial stiffening and increases pulsatile components of pressure and so may lead to left ventricular overload and hypertrophy. These considerations explain that calcification of coronary arteries, which specifically reflects atherosclerosis, is a valuable and strong predictor of occlusive coronary heart disease events, whereas the prognosis of noncoronary calcium, obscured by the possibility that calcium can be deposited within the media and/or the intima layer, is less clear. However, a recent meta-analysis has shown that noncoronary calcification, measured with different imaging methods in populations with different baseline risk, increased substantially (3 to 4 times) the risk for mortality and cardiovascular events, particularly for calcification identified in the thoracic aorta. A complementary question is whether a combination of calcification measures in multiple vascular beds rather than measurement in a single territory may yield the best information. Although the cross-sectional design of the work by Jensky et al does not provide any prognostic information on that issue, it shows that the number of coronary and noncoronary sites with present calcification did not correlate with blood pressure measures independent of coexisting risk factors probably because of arterial bed–related specificity in the hypertension-calcification relationship.

In conclusion, noninvasive, calcium-based imaging with whole body contrast CT may seem attractive for assessing the extent and the severity of subclinical disease in multiple beds, especially in the presence of systolic hypertension that promotes calcium deposit in coronary and noncoronary vessels. However, its clinical applicability and use are questionable, because there is no evidence that screening for coronary and noncoronary calcification may provide incremental information beyond screening only for coronary artery calcium, whereas whole body CT for calcium detection in multiple beds can induce significantly greater radiation exposure than cardiac CT for coronary calcium detection.

Disclosures
None.

References
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