Mini Review

Ageing and coronary arterial calcification

Abstract

The aged coronary artery is characterized by proliferation of atheroma plaque and arterial calcification with progressively increased stiffness. The coronary artery calcium amount and severity is correlation with coronary plaque burden and with increased risk of adverse cardiovascular outcomes. Coronary calcification can be considered as an indirect plaque vulnerability factor, because coronary artery calcium score does not predict the segment that will undergo rupture but identifies vulnerable patients at risk of fatal cardiac events. A calcified nodule is a type of potentially vulnerable plaque related to myocardial infarction and sudden death. A calcified nodule must be discriminated from non-nodular calcium because a former is a kind of vulnerable plaque. Calcified nodules have distinct intravascular ultrasound and optical coherence tomography findings permitting their identification in vivo during intervention.

Keywords: ageing, atherosclerosis, vascular calcification, ultrasonography, interventional, tomography, optical coherence

Jin Bae Lee
Division of Cardiology, Daegu Catholic University Medical Center, Korea

Correspondence: Jin Bae Lee, Division of Cardiology, Daegu Catholic University Medical Center, Daegu, Korea, 33, Duryugongwon-ro 17-gil, nam-gu, daegu, Korea, Tel 82-53-650-3010, Fax 82-53-651-4044, Email jblee@cu.ac.kr

Abbreviations: IVUS, intravascular ultrasound; OCT, optical coherence tomography

Introduction

Coronary atherosclerosis with calcification increases with age. Coronary calcification identifies vulnerable patients at risk of fatal adverse cardiac events in demographic point of view.[1,2] Calcification of the coronary arteries is known to be accompanied by atherosclerosis and is a predictor of stenosis.[3,5] However, whether or not the stability of atherosclerotic plaque is related to coronary artery calcification is still controversial. Calcium deposits begin from the beginning of atherosclerosis and increase as the atherosclerotic process progresses.[6] It has been reported that the severity of coronary artery disease is somewhat related to the degree of calcification in atherosclerotic plaques.[7] We can detect and qualify coronary calcium by using various imaging modalities. Generally, most of coronary artery calcium itself does not predict future plaque rupture or thrombus. Nevertheless, a calcified nodule is a type of vulnerable plaque related to sudden thrombotic cardiac death.[8,9]

Discussion

Pathophysiology of coronary calcification

Calcification of the vascular wall is degenerative and believed to occur late in the atherosclerosis, but recent studies have shown that calcification occurs from the onset of atherosclerosis.[10] Inflammatory responses are involved in the progression and calcification of atherosclerosis and can involve genetic dysplasia of matrix inhibitory proteins or tumor necrosis factor.[11] The inflammatory response is involved in the progression and calcification of atherosclerosis. The risk of coronary artery calcification is increased in proportion to the duration of diabetes, hypertension, clinically significant coronary artery disease, or serum creatinine level. It is commonly found in chronic inflammatory diseases such as Takayasu's vasculitis and giant cell vasculitis and increases calcification in the graft vessels.[12] In the epidemiologic study in the general population, calcification of the coronary arteries increases with age, and is usually found in dialysis patients. The incidence of coronary artery calcification in patients with acute myocardial infarction has been reported to be higher in patients with acute coronary syndrome than in patients with stable

coronary artery disease.[13,14] Several mechanisms were involved in accelerate plaque vulnerability in elderly patients such as increased proinflammatory status, endothelial adhesion of inflammatory cells, increased absorption of atherosclerogenic lipoprotein, increase in the necrotic lipid core and calcification of plaque.[15,16]

Detection of coronary calcium

Coronary artery calcification is detectable in vivo by using coronary arteriography, fluoroscopy, conventional, helical, and electron beam computed tomography, magnetic resonance imaging, intravascular ultrasound(IVUS), and optical coherence tomography(OCT). In current practice, fluoroscopy and CT are commonly used to detect coronary calcification noninvasively, however IVUS and OCT are used by coronary interventionists to evaluate calcification in specific lesions before angioplasty. Intravascular ultrasound findings of coronary artery calcification are more intense than adventitia with shadowing; Hyperechoic plaque with shadowing is highly sensitive finding, however reverberations are highly specific finding.[17] OCT finding of calcium appears as a signal-poor or heterogeneous region with sharply delineated leading, trailing, and/or lateral borders. The signal-poor regions of calcium are sharply demarked, on the other hand the signal-poor regions of lipid or a necrotic core have poorly defined or diffuse borders.[18]

Differentiation between calcified nodule and non-nodular calcification

The histologic features of calcified nodules are ruptured fibrous membranes, intense calcified nodules, and fibrous nodules often accompanied by osteoblasts, osteoclasts, and infiltration of inflammatory cells. Whereas calcified fibrosis (non- nodular calcium) is characterized by collagen rich plaque with large calcification, few inflammatory cells, and a necrotic core.[8,9] A calcified nodule must be discriminated from a non-nodular calcified plaque usually containing large lump of calcification with few inflammatory cells with very small or little amount of necrotic core, and without associated thrombi.[7] Our research group performed the first histopathologic validation of the intravascular ultrasound diagnosis of calcified coronary artery nodules. Intra-vascular ultrasonography findings of calcified nodules compared with non-nodular calcifications are characterized by the appearance of atherosclerotic plaque and the surface of the calcified

lesion convex to the lumen and irregular surface of atherosclerotic plaque and calcified lesions. Non-nodular calcified lesions are characterized by the appearance of atherosclerotic plaques and the surface of calcified lesions concave towards the lumen and the surface of atherosclerotic plaque and calcified lesions are regular.[19] OCT findings of calcified nodule are calcification protruding into lumen through a disrupted fibrous cap overlying superficial calcification with or without thrombus.[20]

Conclusion

Ageing is the most powerful risk factor of atherosclerosis. The incidence and prevalence of cardiovascular disease tend to increase ageing. The aged artery is characterized by arterial calcification. The calcification process in atherosclerotic lesions appears to be associated with lipid oxidation, endothelial damage and the secondary inflammatory response. Calcified nodule is a kind of vulnerable plaque which is different from non-nodular calcium in terms of pathologic and intravascular imaging characteristics.

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Conflicts of interest

Authors declare there is no conflict of interest in composing this manuscript.

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