

Effect of the thickness of fibrous cap and compositions on the rupture behaviour of the atherosclerosis plaques

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Abstract

Atherosclerotic plaque rupture is the leading cause of the cardiovascular diseases (CVD) such as coronary arteries disease, stroke and heart attack. Early detection of the plaques which are prone to the rupture, also known as vulnerable plaque, can provide important clinical information to prevent the fatal cardiovascular event. The vulnerable plaques are commonly characterized as the large lipid core and thin fibrous caps with the thickness less than $65\mu\text{m}$. However, evidence showed that plaques with fibrous caps $> 65\mu\text{m}$ are also susceptible to plaque rupture or erosion and can cause acute myocardial infarction and sudden death^[1]. The effect of the critical thickness of fibrous cap and compositions of the plaques on the rupture behaviour of the arterial plaques has not been fully investigated. In this study, the artificial plaques with a variety of the compositions (lipid core, calcium and collagen) and with a range of thickness of fibrous cap were fabricated. The mechanical properties of the plaques were tested by using the unconfined compression testing. Meanwhile, the deformation of the arterial plaques samples and rupture behaviours were also recorded by using the high-resolution of camera. The initiation and propagation of the rupture of fibrous cap were analysed using digital image correlation (DIC) software. The experimental results indicated that the thicker the fibrous cap, the stiffer the arterial plaque. This phenomenon was observed in the plaques with large lipid core and calcified plaques. The Young's module for the plaques with large lipid core (Figure 1a) ranges from 0.0235 to 3.7174 MPa which are compatible with the value of plaques in the human carotid arteries which were observed in the clinical findings. The plaques with higher percentage of collagen possess the the greater Young's modules (Figure 1b).

Reference

[1] Liu, X., He, W., Hong, X. *et al.* New insights into fibrous cap thickness of vulnerable plaques assessed by optical coherence tomography. *BMC Cardiovasc Disord* **22**, 484 (2022).

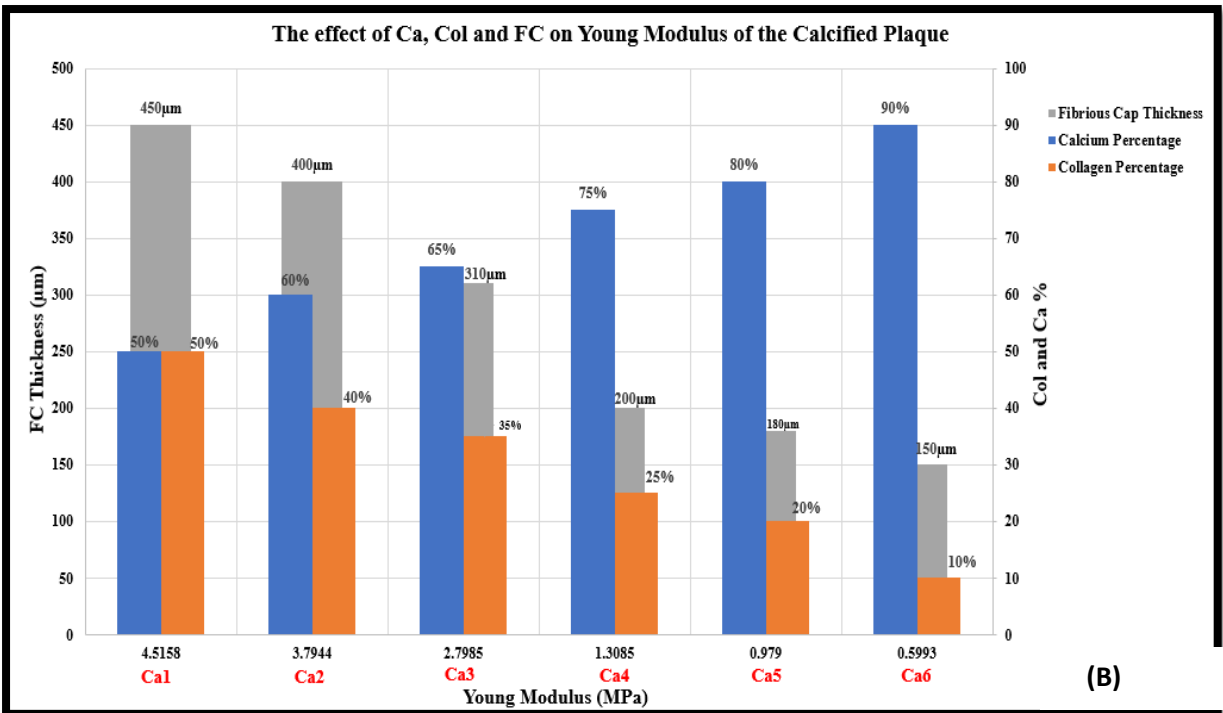
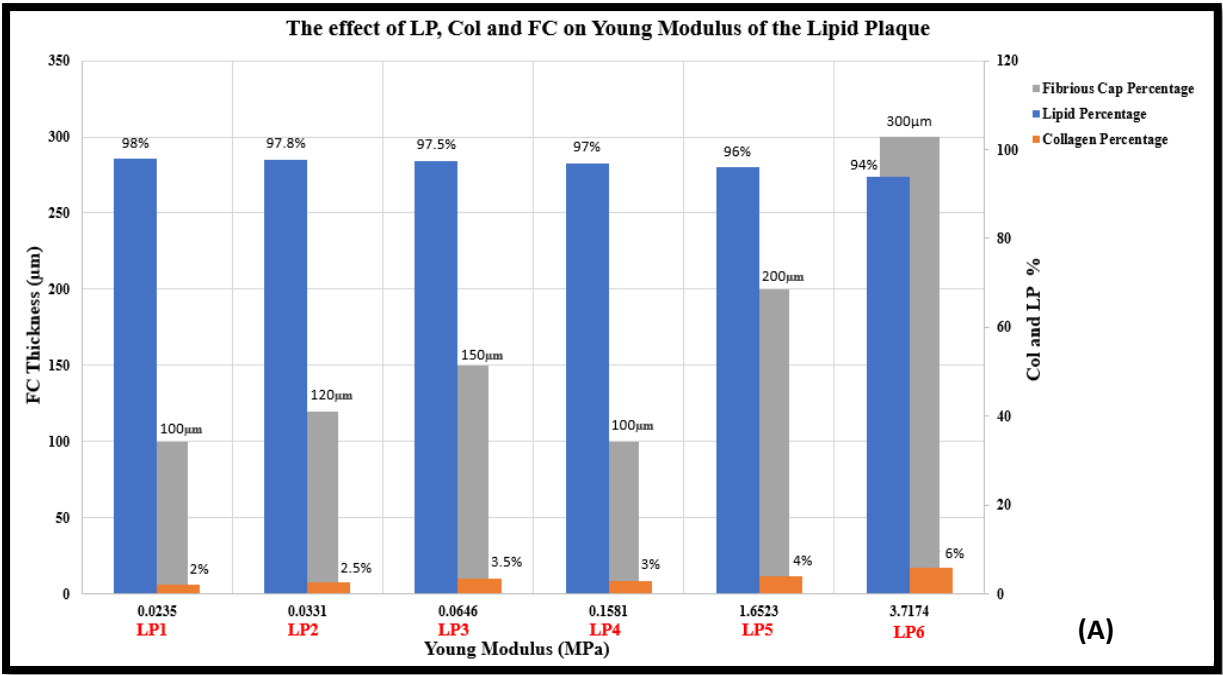


Figure 1 shows the effect of the compositions and thickness of fibrous cap on the material properties of the arterial plaques. Figure 1(A) shows the results for the plaques with the large lipid core which represents the vulnerable plaques while Figure 1(B) shows the results for the plaques for the calcified plaques which represents the stable plaques.