Non-Calcified Coronary Artery Plaque Characterization by Dual Energy Computed Tomography (DECT)

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Abstract

Background: One of the most important causes of mortality in developed and developing countries is coronary artery disease. Coronary artery disease (CAD) may develop by deposition of lipid, fibrous or calcified debris on the surface of the coronary artery lumen. Fibrous plaque and calcified plaque may cause substantial stenosis of coronary arteries leading to ischemia of heart muscle while lipid core plaque with thin fibrous cap is generally non-stenotic. Lipid core plaques have higher risk of rupture, leading to future cardiovascular events and even sudden death. Single energy, conventional CT scanners may demonstrate the calcified plaques easily but they are of limited use in properly characterizing the plaques, specifically in evaluation of fibrous components, lipid core plaque or evaluation of mixed plaques. The main aim of this study was to characterize non calcified coronary artery plaque utilizing dual-energy computed tomography (DECT) system.

Methods: Decomposition of non-calcified coronary artery plaque was done in terms of effective atomic number (Z_{eff}) and electron density (ρe) by utilizing DECT. Calibration was done by CT scanning employing known chemical compounds and mixtures, at 100 and 140 kVp, by dual source dual energy CT system. The inversion algorithm was applied to the CT data of the excised coronary artery (ex-vivo) from the heart of the cadaver and the result was verified with pathological report of these ex-vivo samples.

Results: The results demonstrated that the HU (100) and HU (140) sets of values measured in non-calcified plaque cannot adequately characterize the nature of the plaque. Upon applying our inversion algorithm to non-calcified plaques, the collected data may be able to characterize the type of the plaque into, fibrous plaque, fibro-lipid plaque with micro-calcification, and lipid plaque containing small amounts of micro-calcification. Our results corroborated with histopathology studies in 63% of the cases.

Conclusions: This study (first of this kind) shows that DECT method has potential to characterize the non-calcified coronary artery plaque.

Keywords: Dual-Energy CT, Non-Calcified Plaque, Characterization

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