Radiation dose reduction techniques in cardiac computed tomography: analysis of myocardial perfusion and coronary arteries

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Purpose: A combined CT coronary angiography and myocardial perfusion study not only provides morphological information of coronary artery stenoses, but also provides insight into their functional significance. When coronary angiographic information can be extracted from a myocardial perfusion scan, exposure to both exogenous contrast agents and ionizing radiation can be reduced. However, current dynamic myocardial perfusion scans potentially require a high radiation dose due to the long imaging time needed to record the contrast dynamics. We are investigating low tube current scanning in combination with noise reduction techniques in dynamic CT myocardial perfusion studies and determining the angiographic information that can be extracted from a perfusion scan.

Methods: Statistical iterative reconstruction (SIR) methods, the HighlY constrained backPRjection (HYPR) method and the Dose Reduction using Prior Image Constrained Compressed Sensing (DR-PICCS) method were applied to dynamic CT myocardial perfusion datasets acquired at low dose. High dose scans were also acquired and reconstructed using the conventional Filtered Back Projection (FBP) method. Analyses of myocardial perfusion and coronary arteries were performed and compared between the low dose images with noise reduction and the high dose FBP images.

Results: With low dose data sets, all three methods were able to achieve an image noise level comparable to that of a high dose FBP image. Both perfusion and coronary artery analyses showed good agreement between the noise reduced low dose reconstructions and the high dose FBP reconstructions. The low dose FBP images were so noisy they were non-diagnostic. At extremely low dose levels, the statistical reconstruction method was able to mitigate structured noise (i.e., streaks) caused by photon starvation.

Conclusions: SIR, HYPR and DR-PICCS methods are able to reconstruct images acquired at low dose with lower image noise when compared with the conventional FBP method. SIR in particular can mitigate streaks caused by photon starvation in extreme low dose situations. All three methods enable qualitatively good and quantitatively accurate myocardial perfusion and coronary artery analyses from datasets acquired at low dose.