Performance of Iterative Reconstruction Algorithms

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Radiation dose continues to be a concern for patients undergoing clinical CT exams. There are approximately 80 million CT exams in the US every year. With traditional filtered backprojection (FBP) reconstruction, reduction in radiation exposure results in images with increased noise (pixel standard deviation) which limits low contrast detectability and overall image quality. Recently, new iterative reconstruction algorithms are being used, promising reduced radiation dose while preserving image quality.

Current iterative reconstruction algorithms work in either the image domain (IRIS), the data domain (Veo, SAFIRE), or both (AIDR, ASIR, iDose). The main advantage of working in the image domain is processing speed while the main advantage of data domain processing is the incorporation of scanner physics into the forward projection model. While all these algorithms promise the preservation of image quality, classic definitions of image quality that are based on the assumption of a linear reconstruction algorithm may not be appropriate with the non-linear iterative algorithms.

When analyzing dose reduction with FBP, image pixel noise is often used as a proxy for overall image quality. However, with iterative reconstruction, image pixel noise no longer adequately represents overall image quality. First of all, image spatial resolution can be dependent on image contrast. Iterative algorithms can recognize sharp, well-defined edges and preserver or enhance them. However, edges with lower contrast may not be as well recognized and smoothed over. Secondly, iterative reconstruction algorithms may change the texture of image noise while reducing its magnitude. These texture changes can affect an observer's ability to discern low contrast objects from image background. Therefore, new metrics such as noise power spectrum (NPS) must be used to evaluate the relationship between radiation dose and image noise texture. Furthermore, recent work has focused on modeling observer response to specific imaging tasks, such as low contrast detectability. Observer studies, whether algorithmic "models" or human in nature, can estimate the effectiveness of these algorithms in real world scenarios.

This talk will review currently available iterative algorithms and their design. Following, we will explore image quality metrics relevant to dose reduction in the age of iterative reconstruction including noise power spectrum and observer studies. Finally, we will discuss the clinical impact of iterative reconstruction algorithms and their performance in routine practice.

Learning Objectives

1) Basics of image domain and data domain iterative reconstruction algorithms
2) Image quality metrics relevant to iterative reconstruction
3) Design and utility of observer studies- model and human
4) Clinical impact of iterative reconstruction