Mathematical reduction of artifacts in limited projection and limited angle cone beam CT

Purpose: Modern radiation therapy delivery and imaging systems include flat panel imagers and kV sources. These systems are used to generate projections for cone beam CT (CBCT) reconstructions using filtered backprojection (FBP) algorithms. FBP works best when a large number of projections are taken over 360 degrees; however, the resultant daily dose is of concern. Two methodologies for dose reduction are limited projection number and limited arc acquisition. In this study we examine reconstruction degradation from these two dose reduction methods and present initial solutions to reduce these artifacts.

Method: Our initial dataset consisted of a 360 image 360 degree projection dataset acquired on the Nucletron Digital Integrated Brachytherapy Unit (IBU-D) of a water-filled Jaszczak Phantom containing spheres of varying contrast. FBP reconstructions were performed on the full dataset, a 16 image limited projection dataset, and a limited angle (60 projections over a 60 degree arc) dataset. Streaking and smearing artifacts from the dose reduction strategies were examined for both limited projection and limited angle. We developed separate techniques for artifact reduction for each scenario: a powered interpolation technique and a view-by-view weighting technique, respectively. Images were reconstructed using the new techniques and compared.

Results: For the limited projection case, powered interpolation techniques reduce streak artifacts significantly. For the limited angle case, view-by-view weighting reduce the smearing artifact at the edges of the projection data arc, which are caused by limited sampling of the Fourier space.

Conclusion: With dose reduction comes data reduction, which can lead to unavoidable artifacts in both the limited projection and limited angle CBCT cases due to incomplete data. The new powered interpolation method and weighted projection method can effectively reduce these artifacts and improve image quality. **Research supported by Nucletron, BV.**