Purpose: The CT streak artifacts caused by metal implants limit various applications of CT imaging, such as target delineation and accurate dose calculations in radiation therapy. Both interpolation-based one-shot algorithms and iterative reconstruction algorithms have certain limitations in efficiently suppressing the artifacts. The purpose of this work is to develop an effective and robust iterative algorithm to minimize the metal artifacts and achieve clinically acceptable CT images.

Methods and materials: A penalized-weighted-least-squares method is first used to accurately identify the metal objects in image space. The binary metal image is then projected to sinogram to segment out metal corrupted projection data. A constrained-optimization based iterative algorithm is then applied to the remaining data to reconstruct the CT image. The algorithm minimizes the total variation (TV) or an anisotropically penalized smoothness (PS) of the image, subject to a data fidelity constraint, with image non-negativity enforced. The constrained minimization problem is solved through the alternation of projection onto convex sets (POCS) and steepest gradient descent of the objective function. The algorithm is evaluated using two numerical phantoms (shepp-logan and QA, 350x350 (in pixels)) and experimental CatPhan®600 phantom. The experimental projection data was acquired using cone-beam CT lose dose protocol (10mA/10ms), including 680 views for a full 360^{o} rotation.

Results: Both simulation and experimental studies showed that the constrained optimization algorithm has superior performance compared with analytical FDK algorithm. It significantly suppressed metal artifacts even in the presence of noise and system imperfections. The FWHM comparisons on CatPhan®600 suggested that image reconstructed by constrained optimization has a higher resolution than FDK reconstruction.

Conclusion: The proposed constrained optimization algorithm can be used to significantly reduce metal artifacts and produce clinically acceptable image with relatively low dose. The proposed algorithm can also be generated to other incomplete/missing data problems in systems involving x-ray source trajectories.