

Purpose: To develop novel methods for CT artifact reduction in patients with metallic implants, specifically tailored to implant materials commonly used in clinical practice. To retrospectively evaluate the performance of these methods using clinical scan data.

Methods: Two artifact reduction methods were developed. A physics-based method was designed that corrects for first-order beam hardening effects, without requiring specific knowledge about the implant or X-ray spectrum. A limited data reconstruction method was developed for implants which fully attenuate X-rays, with smoothness regularization in image space. Both methods were retrospectively applied to projection data obtained from a GE LightSpeed RT 16 scanner of patients with different metallic implants.

Results: Artifacts in patients scans of the both spinal and head & neck regions were significantly reduced. It was shown that beam hardening is the primary cause of artifacts due to titanium orthopedic hardware. Best results were therefore obtained using physics-based correction, because information in all projection measurements is preserved. High-density implants such as platinum fully attenuated the CT X-rays. In this case, artifacts were reduced using the limited data reconstruction method. Smoothness regularization ensured clinically sensible solutions.

Conclusions: The physical origin of CT metal artifacts depends on the material of the implant. For effective artifact reduction, methods should be tailored to specific implants in order to maximize the use of information in the CT projections. Using appropriate methods for either low- or high-density metallic implants, clinical scans are significantly improved.