Abstract No. ABS 000047

Metal Artifact Reduction by Monoenergetic Extrapolation of Dual Energy CT in Patients with Metallic Implants

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Objective

To assess artifact reduction and image quality by using dual energy CT (DECT) and metal artefact reduction techniques in patients with metallic implants.

Methods & Materials

25 patients with metallic implants (M:F=10:15,age=27-87years) , who had targeted CT performed by dual energy CT during March to June 2018, were prospectively recruited. CT scans of the LS spine (n=12),C spine (n=1), hip (n=4), knee (n=1), ankle (n=5) and wrist (n=2) were included. Post-processing with monoenergetic extrapolation at 70keV and 150keV was performed. 25 matched controls with metallic implants with single energy CT (SECT) performed were selected. Attenuation value, noise and signal to noise ratio at site of maximal artifact were measured at muscle and fat areas. Image quality of 3 sets of images (70keV, 150keV and SECT) were assessed by two independent reviewers using a 5 point Likert Scale. Statistical analysis of measured values, Likert scales and radiation doses (CTDIvol) of DECT and SECT were performed with Mann-Whitney U test.

Results

Streak artefacts from metallic implants were reduced with high keV reconstruction compared to both low keV of DECT and SECT in terms of mean attenuation values in surrounding muscle and fat (both $p<0.010$). Comparing the SNR within the surrounding muscle, high keV reconstruction demonstrated higher SNR compared to both low keV of DECT and SECT (both $p<0.010$). In the surrounding fat, the high keV showed higher SNR compared to low keV reconstruction ($p<0.010$), while the SNR were comparable between the high keV reconstruction and SECT ($p=0.177$). Image quality of high keV reconstruction was rated superior to the other two groups. The radiation dose in terms of CTDIvol were comparable between DECT and conventional SECT ($p=0.07$).

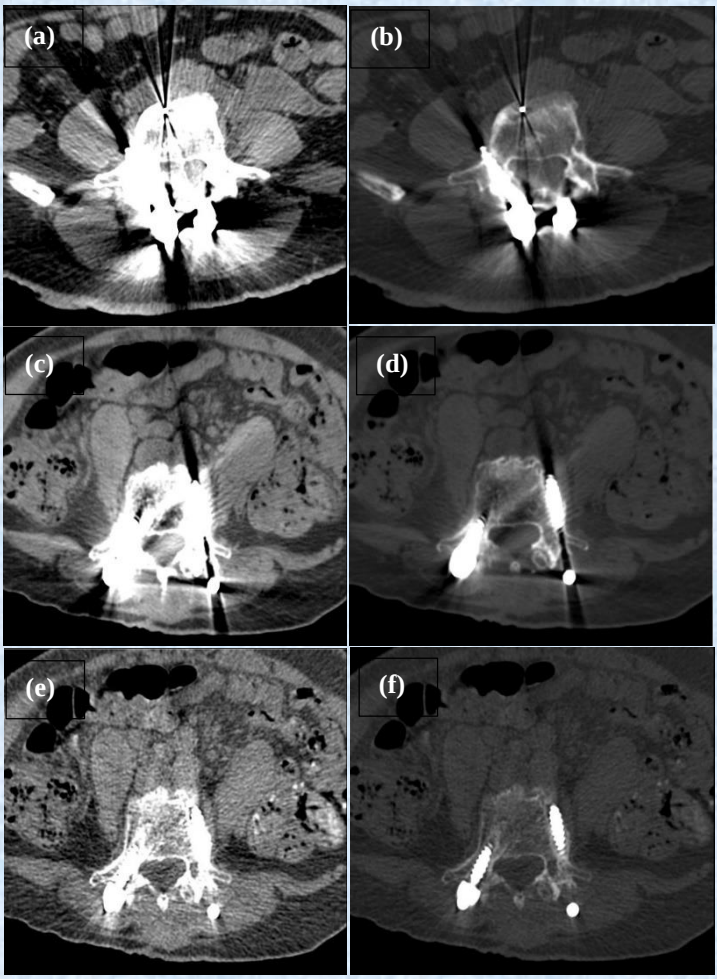

Figure 2. CT images of 2 patients with pedicle screws. (a) and (b) are conventional single energy CT in soft tissue and bone windows respectively. (c) to (f) belong to same set of CT images reconstructed in different energy levels. (c) and (d) are dual energy CT in low energy (70 keV) reconstruction in soft tissue and bone windows respectively. (e) and (f) are dual energy CT in high energy (150 keV) reconstruction in soft tissue and bone windows respectively. Significant interval decrease in metallic artifacts and less obscuration of surrounding muscle and fat are seen in (e) and (f). The malposition of the left pedicle screw is clearly visualized.

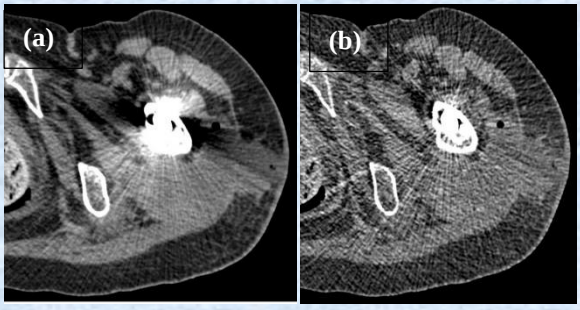

Figure 1. Axial DECT images with a) 70keV and b) 150 keV reconstruction in soft tissue window of a patient with left hip unipolar arthroplasty. At 150keV, reduced artifact and better appreciation of the collection at left gluteal region are noted.

Conclusion

Our study showed that for patients with metallic implants, monoenergetic extrapolation of DECT at theoretical 150keV can reduce metal artifacts, increase SNR and improve qualitative image quality at comparable radiation dose.