

A Study of the Image Quality of CT Brain Adaptive Statistical Iterative Reconstructed (ASIR) Images Using Subjective and Objective Methods

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Purpose: The aim of this study was to investigate the image quality of ASIR reconstructed brain images using subjective, observer-based assessment and objective metrics to elucidate trends and possible alternatives to the current standard protocol featuring 40%ASIR and a noise index of 11.20, possibly facilitating a dose decrease.

Method: An audit of image quality of patient brain scans (n=55) was performed using Visual Grading Assessment (VGA) by two radiologist-observers, using CEC image criteria of retrospectively reconstructed images at 0% -70% & 100% ASIR-levels originally scanned using the standard protocol. Analysis was conducted using Visual Grading Characteristics (VGC). Empirical phantom-based assessments of high-contrast spatial resolution (HCSR) and Noise Power Spectrum (NPS) with 0-100%ASIR increments and decrementing tube currents (565-235mA), were also conducted.

Results: VGC analysis showed that the mid-range increments (50%-70%ASIR) were not significantly different to 40%ASIR ($p>0.05$). Low-contrast spatial resolution (LCSR) showed slight, non-significant improvement with 70% and 60%ASIR increments compared with 40%ASIR ($p>0.05$). Subjective image noise remained constant across this range, but was slightly worse than 40%ASIR ($p>0.05$). However, 70%ASIR reconstructions were found to be overly susceptible to artefact appearance. Hence pairwise-analysis was performed using 60% & 50%ASIR, which showed 60%ASIR was the preferred increment. Phantom-based HCSR investigations showed MTF_{50} and MTF_{10} increases of up-to 4.1% and 3.0%, respectively ($p<0.05$) for ASIR reconstructed images as compared to those produced using FBP. MTF_{50} and MTF_{10} showed a linearly improving relationship with increasing %ASIR. With tube current, MTF behaviour was more complex with a rapid increase up to 305mA, a plateau between 305 and 420mA and then a rapid fall off. The NPS study revealed peak-frequency decreased linearly with increasing %ASIR and remained constant with tube current. Peak-variance decreased non-linearly with %ASIR and tube current. Empirical ranges for MTF_{50} , MTF_{10} , peak frequency NPS & peak variance NPS of (0.370- 0.375 mm^{-1}), (0.617- 0.622 mm^{-1}), (0.199- 0.176 mm^{-1}) & (99.28- 84.92 mm^{-1}) respectively, were obtained for the standard protocol for the mid-range ASIR increments.

Conclusion: This study demonstrated the trends for objective and subjective image quality metrics with ASIR increment and tube-current. 60%ASIR with a tube current of 305mA (NI=12.20) was proposed as an alternative to the current standard, as it was the best fit with these empirical ranges, producing a possible dose saving of 16.1%.