A comparison between adaptive statistical iterative reconstruction (ASiR) and new ASiR-V techniques for dose reduction and image quality assessment in abdominal CT: A phantom study

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Aims and objectives

Dose reduction in body CT is nowadays a top priority among patients and the health care community because of a potentially increased risk associated with ionizing radiation. However, dose reduction must be balanced by an acceptable level of image quality as well as diagnostic accuracy must be adequately maintained.

Over the past decades, CT manufacturers introduced a variety of strategies but the most promising are the iterative reconstruction algorithms that have evolved beyond the traditional reconstruction method of filtered back projection (FBP). In fact, iterative reconstruction techniques permit to preserve a good overall image quality on low-dose studies. Adaptive statistical iterative reconstruction (ASIR, GE Healthcare) has been the most used algorithm to date, providing dose reductions from 20 up to 40%.

Recently, a novel adaptive statistical iterative reconstruction (ASIR-V, GE Healthcare) was introduced. This technique uses a nearly full iterative reconstruction process with the potential for clinically feasible dose reduction with better image quality than conventional ASIR, as well as a shorter imaging processing time.

The aim of this study was to investigate whether the overall image quality of ultra-low dose CT images, reconstructed with (ASiR-V, GE Healthcare), resulted to be maintained when compared with the routine radiation dose CT images reconstructed with ASIR.
Methods and materials

Data acquisition A Catphan 600 (The Phantom Laboratory, Incorporated) reference phantom was used. Images were acquired with a 128-slice multidetector Optima 660 CT (GE Healthcare, USA) using the protocol clinically adopted in our Institute (120 kVp, 2.5 mm slice thickness, fixed noise index (NI) of 18). Reduced radiation dose CT scans were performed on using the same CT scanner considering NI equal to 30. A further acquisition with a NI of 10 was performed in order to obtain high-dose CT images used in the following study as qualitative reference.

Data reconstruction Post-processing reconstructions were performed using FBP for high-dose acquisitions, standard ASiR for clinical acquisitions and novel ASiR-V algorithm for reduced dose acquisitions, respectively. In particular, percentage blending varied from 10 to 100% both for ASiR and ASiR-V.

Investigated parameters Quantitative analysis was based on the following parameters: uniformity (%), image noise (HU), MTF f50 (lp/mm 50%) and f10 (lp/mm 10%), SNR (%), CNR (1%, 0.5% and mean CNR). All above-mentioned parameters were investigated against NI and iterative reconstruction algorithm blending percentage. In particular, the uniformity and the noise value properties were characterized from Catphan uniform module (CTP 485). The transverse spatial resolution was characterized through the in-plane MTF. To calculate it, a Region of Interest (ROI) centered on the bead point object image of the Catphan point source module (CTP 528), was selected. Moreover, the SNR parameter was evaluated using the Catphan CTP 404 module while the CNR using the sub-slice and supra-slice low contrast module (CTP 515).
Results

**Uniformity.** A statistically significant difference in the uniformity was observed at the phantom’s center with 60%ASiR-V of blending for images with NI 30. The closest ASiR blending percentage to FBP reference value was the 10%. No substantial differences were observed when evaluating uniformity within ASiR (NI 18) and between ASiR and FBP (NI 10).

**CNR.** Mean CNR increased against blending with a slope of 0.006 and 0.008 for ASiR and ASiR-V, respectively. All ASiR and ASiR-V values resulted to be lower than value obtained for FBP images. Similar considerations can be drawn for CNR 1% and 0.5%.

**MTF.** ASiR-V showed to have a good agreement with FBP value with respect to ASiR for all percentages when evaluating MTF f10. In particular, values obtained with ASiR-V from 10% to 50% were higher than FBP values, while data obtained from 60% to 100% of blending resulted equal to the FBP reference value.

With the only exception of 10%ASiR, the MTF f50 increased both for ASiR and ASiR-V reconstruction with respect to FBP. Indeed, ASiR-V reconstruction provided the best MTF f50 values.

**Image noise.** Image noise decreases with blending for both reconstruction algorithms. ASiR-V provided the poorest results when compared with FBP and ASiR.

**SNR.** SNR increased with blending but decreased when comparing ASiR with ASiR-V. High ASiR-V blending percentages are needed to match the SNR reference value obtained with FBP.
Fig. 1: Uniformity

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Fig. 2: Mean CNR

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Fig. 3: MTF f10

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Fig. 4: MTF f50

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Fig. 5: Image Noise

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Fig. 6: SNR

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Conclusion

This preliminary study aimed at demonstrating that a novel iterative reconstruction algorithm such as ASiR-V allows to significantly reduced dose while maintaining a good overall image quality. However, our results showed that the use of ASiR-V do not permits to recover the same image quality obtained using ASiR or FBP algorithms when dealing with ultra low-dose CT images. This is likely due to the fact that the NI selected (equal to 30) was too high so that the corresponding dose reduction severely affected the image quality of reconstructed data. Further investigations involving Catphan 600 CT acquisitions using a NI between 20 and 25 are ongoing within our Institute in order to obtain the optimal balance between image quality and dose.
References


