Feasibility study of thin-section brain CT in the routine dose protocol with a new iterative reconstruction technique

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Aims and objectives

The purpose of the present study was to assess the feasibility of a knowledge-based iterative model reconstruction (IMR) in the routine dose protocol brain CT, and also investigate the quantitative and qualitative of thin slice and routine slice thickness brain CT image with IMR, iDose\(^4\) and filtered back projection (FBP) techniques.

Methods and materials

We randomly selected brain CT images who with no obvious pathology from patient complaint of headache, dizziness and weakness between June 2014 and October 2014. Thus, the study included sixty-one patients (33 men, 28 women; 45.2 ± 14.43 mean age years) who underwent brain CT examinations. All patients were examined on a 256-slice CT system (Brilliance iCT; Philips Healthcare, Cleveland, OH). The CT parameters were: detector collimation, 64 x 0.625 mm; rotation time, 0.5 seconds; pitch, 0.391; fields of view, 250 mm; tube voltage, 120 kV, and the tube current-time product, 300 mAs. The mean volume CT dose index (CTDI\(_{\text{vol}}\)) was 41.4mGy and dose length product (DLP) was 706.1mGy*cm. Images were reconstructed with a routine slice thickness of 5.0mm and thin slice thickness of 1.0mm by IMR, iDose\(^4\) and FBP techniques, respectively. We reconstructed the raw data with a 512 x 512 pixel matrix, 1.0-mm slice thickness at intervals of 0.5-mm and 5.0-mm slice thickness at 2.5-mm intervals by FBP, iDose\(^4\) and IMR algorithms. Objective analysis including CT attenuation, noise, contrast-to-noise ratio (CNR) and artifacts index of posterior cranial fossa were calculated. For the evaluation of the contrast between WM and GM, two pairs of region-of-interest (ROI) measurements of CT attenuation (in HU) were placed at the following anatomic locations on the levels of centrum semiovale and basal ganglia of 2 slice thickness (1.0 and 5.0 mm): two in centrum semiovale deep WM, two in adjacent cortical GM, two in thalamic deep GM and two in the WM of the posterior limbic of the internal capsule. Additionally, to assessment the image quality in posterior cranial fossa, another ROI was located in the interpetrous region of the posterior cranial fossa on the slice with the highest degree of beam-hardening and/or streak artifact [1]. Subjective analysis including artifacts, noise, visualization of structure, and diagnostic acceptability of image were assessed blindly by 2 neuro-radiologists using a five-point scales.

Results
There was no significant difference of CT attenuation between IMR, iDose\(^4\) and FBP techniques for both routine and thin slice \((P>0.05)\) (see figure1). Image noise was significantly lower and the CNR were significantly higher on IMR images by comparison with those on iDose\(^4\) and FBP images of both routine and thin slices \((P<0.01)\) (see figure2 and table1). The image quality improved and artifact index reduced (see figure3 and figure4). While between the subjective image qualities, the scores were significantly higher on IMR images of both slice thickness compared to iDose\(^4\) and FBP \((P<0.01)\).

**Images for this section:**

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**Fig. 1:** Scatter plots show results of objective analysis of CT attenuation with IMR, iDose\(^4\), and FBP techniques. Center horizontal lines show median values, and whiskers show upper and lower quartiles. CT attenuation value of brain image was not significantly different among three reconstruction techniques for both 1.0mm slice and 5.0mm slice thickness.
Fig. 2: Scatter plots show results of objective analysis of image quality obtained with IMR, iDose4, and FBP techniques. Center horizontal lines show median values, and whiskers show upper and lower quartiles. Image noise was significantly different among three reconstructions for both 1.0mm slice and 5.0mm slice thickness (IMR vs iDose4; IMR vs FBP; iDose4 vs FBP).

Fig. 3: FBP vs. iDose vs. IMR in a 49-year-old man with coronary artery disease who underwent routine dose brain CT scan. Image noise, resolution, and depiction of anatomic structure with the use of IMR were better compared to FBP and iDose4 for 1.0mm slice thickness.
Fig. 4: comparison of artifact index in the posterior cranial fossa of the brain between the IMR, iDose4 and FBP images for both 1.0mm slice thickness. (a) FBP shows obvious beam-hardening artifact with artifact index value of 13.4 Hounsfield units (HU); (b) iDose4 shows slightly beam-hardening artifact with artifact index value of 9.6 HU; (c) IMR show much less artifact index value with 6.3 HU in 1.0mm slice, respectively.

Table 1: CNR in each region of interest
Conclusion

A knowledge-based IMR, as a newly developed technique with full IR reconstruction algorithm, which incorporates system optics as well as photon and noise statistics has been developed [2]. Until now, studies on brain CT have shown the benefit of the hybrid iterative reconstruction (HIR) and Model-based IR (MBIR) technique in terms of lower image noise and radiation dose [3-5]. It was reported that IMR can better reduce image noise, radiation dose and improved low-contrast lesions than FBP and HIR in abdominal, coronary CT studies [6-11].

To the best of our knowledge, this is the first clinical study to directly compare image quality characteristics of brain CT in the same patients with three difference reconstruction methods, IMR, iDose\(^4\) and FBP. In this study, we found that both thin slice and routine slice thickness using IMR technique significantly reduced image noise, artifacts, improved CNR while maintaining the image quality and without CT attenuation changed in the brain CT when compared with iDose\(^4\) and FBP. It is also revealed IMR had a high potential in the improvement of image quality.

Image noise, 47.1% and 63.3% reduced in 1.0mm thickness, 29.4% and 48.8% reduced in 5.0mm thickness using IMR compared with iDose\(^4\) and FBP, respectively. We also found beam-hardening and/or streak artifacts related dense surrounding bone of posterior cranial fossa significantly reduced with IMR technique. The results should be attributed to inherent differences in image reconstruction techniques. The discriminate between GM and WM with slightly differing CT attenuation, noise is a significant factor in this condition. According to present study results on noise and artifacts reduction, we believe IMR could be an effective CT examination in area where image noise and artifacts are problematic.

Based on our study results on noise reduction and CNR improvement, we believed that the use of IMR can be further used to reduce the radiation dose of routinely used brain CT while maintaining image quality. Additionally, it cost about 3 min for IMR to reconstruct each thin slice thickness series, while less than 1 min for FBP to reconstruct thin slice thickness series and less than 20s to reconstruct routine slice thickness series, this is can be applicable in the clinical practice.

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References

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