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Iterative Reconstruction Techniques as a Dose Reduction Tool in Pediatric Computed Tomography Imaging: A Phantom Study

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Abstract : Background and Purpose: Computed Tomography (CT) scans have become the largest source of radiation in radiological imaging. The purpose of this study was to compare the quality of pediatric Computed Tomography (CT) images reconstructed using Filtered Back Projection (FBP) with images reconstructed using different strengths of Iterative Reconstruction (IR) technique, and to perform a feasibility study to assess the use of IR techniques as a dose reduction tool. Materials and Methods: An anthropomorphic phantom representing a 5-year old child was scanned, in two stages, using a Siemens Somatom CT unit. In stage one, scans of the head, chest and abdomen were performed using standard protocols recommended by the scanner manufacturer. Images were reconstructed using FBP and 5 different strengths of IR. Contrast-to-Noise Ratios (CNR) were calculated from average CT number and its standard deviation measured in regions of interest created in the lungs, bone, and soft tissues regions of the phantom. Paired t-test and the one-way ANOVA were used to compare the CNR from FBP images with IR images, at $p = 0.05$ level. The lowest strength value of IR that produced the highest CNR was identified. In the second stage, scans of the head was performed with decreased mA(s) values relative to the increase in CNR compared to the standard FBP protocol. CNR values were compared in this stage using Paired t-test at $p = 0.05$ level. Results: Images reconstructed using IR technique had higher CNR values ($p < 0.01$.) in all regions compared to the FBP images, at all strengths of IR. The CNR increased with increasing IR strength of up to 3, in the head and chest images. Increases beyond this strength were insignificant. In abdomen images, CNR continued to increase up to strength 5. The results also indicated that, IR techniques improve CNR by a up to factor of 1.5. Based on the CNR values at strength 3 of IR images and CNR values of FBP images, a reduction in mA(s) of about 20% was identified. The images of the head acquired at 20% reduced mA(s) and reconstructed using IR at strength 3, had similar CNR as FBP images at standard mA(s). In the head scans of the phantom used in this study, it was demonstrated that similar CNR can be achieved even when the mA(s) is reduced by about 20% if IR technique with strength of 3 is used for reconstruction. Conclusions: The IR technique produced better image quality at all strengths of IR in comparison to FBP. IR technique can provide approximately 20% dose reduction in pediatric head CT while maintaining the same image quality as FBP technique.

Keywords : filtered back projection, image quality, iterative reconstruction, pediatric computed tomography imaging
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