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Low radiation dose 256-MDCT angiography of the carotid arteries: Effect of hybrid iterative reconstruction technique on noise, artifacts, and image quality

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ABSTRACT

To evaluate the effect of hybrid iterative reconstruction on qualitative and quantitative parameters at low dose carotid CTA.

Materials and methods: 44 consecutive patients were enrolled in the study. First group ($n=22$) was examined under 120 kV 250 mAs, second group ($n=22$) – 100 kV 250 mAs. CT images in first group were reconstructed only with the filtered back projection (FBP). CT data in second group were reconstructed both with FBP and three levels of hybrid iterative reconstruction algorithm (iDose). We compared quantitative and qualitative parameters among the two groups and among four different reconstructions in second group.

Results: Effective dose in 120 kV and 100 kV group was 7.18 ± 1.19 mSv and 4.14 ± 1.03 mSv, respectively ($p < 0.0001$). Mean arterial attenuation was about 25% higher in second group (236.5 ± 46 HU vs. 302.6 ± 32.7 HU; $p < 0.0001$). Image noise at the level of humeral belt was 32.5 ± 12.5 in 100 kV group and 26.3 ± 13.3 in 120 kV ($p = 0.115$).

Average noise decreased when using 3 levels of iDose up to 23.6 ± 6.4, 17.7 ± 5.6 and 13.7 ± 5.1, respectively ($p = 0.00001$). Mean CNR increased to 10.38 ± 3.87, 14.5 ± 5.21 and 18.32 ± 8.61, respectively ($p < 0.05$).

The presence of artifacts on the level of humeral belt in 120 kV group was 14%, in 100 kV – 41% ($p = 0.002$). The difference in visual scores between standard and low-dose protocol was significant ($p = 0.008$). When applying iterative reconstruction the frequency of streak artifacts decreased dramatically ($p < 0.0001$). Most studies had excellent quality with no artifacts while using highest level of iDose.

Conclusion: According to the results of our study low dose CT angiography using hybrid iterative reconstruction may provide sufficient image quality and allows for significant reduction of patient dose.

1. Introduction

Brain ischemia can be induced by multiple causes, but the most common pathophysiological mechanism is atherosclerotic large-vessel disease. Detection of the atherosclerosis of carotid arteries is essential to reduce the probability of a stroke. CT angiography (CTA) is an accurate method for detection of atherosclerotic lesions of the carotid arteries and for grading the severity of stenosis [1–3]. A cost-effectiveness analysis of non-invasive techniques showed that MDCT angiography would be the preferred method in patients with higher prior probability of atherosclerotic disease of the major arteries [2].

The diagnostic applications of MDCT angiography have improved considerably because of its high spatial resolution, faster contrast material injection, novel reconstruction algorithms, and further perfection of post-processing tools. However, MDCT angiography of the extra- and intracranial arteries has some critical disadvantages such as sensitivity to artifacts, and especially the radiation dose [4,5].

Existing standard scanning protocols allow an effective dose of up to 10 mSv during one scan phase. However patients with carotid atherosclerotic lesions often undergo repeated MDCT examinations, including MDCT scanning of other anatomic regions that further increases the radiation exposure. All this necessitates the revision of established scan protocols for MDCT angiography aiming at reduction of the radiation exposure.

Mazonakis et al. reported that primary irradiation of the thyroid gland during neck MDCT examination results in an absorbed dose in the range of 15.2–52.0 mGy. The risk of development of thyroid malignancies increases up to 390 cases per million patients [6].

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