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Dose Saving and Image Quality Evaluation for Computed Tomography Head Scanning with Eye Protection

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Abstract : Computed tomography (CT) scan of the head is a good method for investigating cranial lesions. However, radiation-induced oxidative stress can be accumulated in the eyes and promote carcinogenesis and cataract. In this regard, we aimed to protect the eyes with barium sulfate shield(s) during CT scans and investigate the resultant image quality and radiation dose to the eye. Patients who underwent health examinations were selectively enrolled in this study in compliance with the protocol approved by the Ethics Committee of the Joint Institutional Review Board at Taipei Medical University. Participants' brains were scanned with a water-based marker simultaneously by a multislice CT scanner (SOMATON Definition Flash) under a fixed tube current-time setting or automatic tube current modulation (TCM). The lens dose was measured by Gafchromic films, whose dose response curve was previously fitted using thermoluminescent dosimeters, with or without barium sulfate or bismuth-antimony shield laid above. For the assessment of image quality CT images at slice planes that exhibit the interested regions on the zygomatic, orbital and nasal bones of the head phantom as well as the water-based marker were used for calculating the signal-to-noise and contrast-to-noise ratios. The application of barium sulfate and bismuth-antimony shields decreased 24% and 47% of the lens dose on average, respectively. Under topogram-based TCM, the dose saving power of bismuth-antimony shield was mitigated whereas that of barium sulfate shield was enhanced. On the other hand, the signal-to-noise and contrast-to-noise ratios of DSCT images were decreased separately by barium sulfate and bismuth-antimony shield, resulting in an overall reduction of the CNR. In contrast, the integration of topogram-based TCM elevated signal difference between the ROIs on the zygomatic bones and eyeballs while preferentially decreasing the signal-to-noise ratios upon the use of barium sulfate shield. The results of this study indicate that the balance between eye exposure and image quality can be optimized by combining eye shields with topogram-based TCM on the multislice scanner. Eye shielding could change the photon attenuation characteristics of tissues that are close to the shield. The application of both shields on eye protection hence is not recommended for seeking intraorbital lesions.

Keywords : computed tomography, barium sulfate shield, dose saving, image quality
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