Purpose: To effectively integrate image-guidance into single dose (24 Gy) SBRT to bony targets, we propose to deliver the treatment in 6 consecutive VMAT arcs and simultaneously acquire a CBCT image during each arc. This would provide a means to check and correct for intra-fractional target motion subsequent to the 1st arc. We investigate the effect of the MV scatter on CBCT image quality and report on the feasibility of simultaneous SBRT / CBCT for intra-fractional imaging.

Methods:The CatPhan and anthropomorphic Rando phantoms were irradiated with 360° arcs using a static 10x10 cm field, and kV CBCT projections were acquired simultaneously. To investigate the effect of MV scatter on CBCT image quality, we varied the phantom size, MV dose and dose rate, CBCT mAs, and the SSD of the kV detector. In addition, a CBCT reconstruction algorithm that reduced the detrimental effects of scattered MV radiation was studied.

Results:: Scattered MV radiation added noise to reconstructed images, decreasing low contrast resolution while reducing Hounsfield Unit (HU) accuracies. Increasing the size of the phantom magnified these effects since the scatter-to-primary ratio is increased. In part, this could be compensated for by increasing the CBCT exposure (mAs), and by increasing the separation between the isocenter and the kV detector from 50 to 80 cm. The new CBCT scatter correction algorithm was shown to offer promise of increasing HU accuracies. With the combined methods to increase SNR, good quality CBCT images that clearly visualize bony targets were obtained, even when 750 MU was delivered in an arc treatment.

Conclusions:For the proposed clinical application, kV-CBCT scans are acquired concomitantly with MV radiation delivery. These images, if automatically registered to the planning CT scan, provide monitoring of possible intra-fractional motion, and allow, if necessary, for corrections to be made.

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