Purpose: To develop a novel method to simultaneously deliver RapidArc® and acquire kV CBCT with minimal MV scatter using the TrueBeam®.
Methods and Materials: A standard RapidArc® plan consists of hundreds of control points (CP) for dose delivery with designed MLC aperture, dose rate, and gantry rotation. In our design concept each original CP is converted into two: one for MV dose delivery, and the other for kV imaging. Gantry intervals of each CP and gantry speed are chosen to acquire sufficient CBCT projections in the imaging CP, while minimizing the process time. kV projections with minimal-MV scatter are selected, based on the recorded gantry angle, and sCBCT (s: without MV-scatter) is reconstructed. For comparison, a reference rCBCT image is acquired without MV dose delivery, and a cCBCT (c: with MV-Scatter) acquired by running the same RapidArc®/CBCT plan but without the imaging CP. CBCT are acquired in both full-fan and half-fan modes.
Results: The image quality of sCBCT and rCBCT are comparable, whereas MV scatter significantly degrades the cCBCT image and contributes artifacts. Image analysis results show that the contrast-to-noise ratio of the sCBCT and rCBCT are comparable, and is twice that of the cCBCT. Likewise, the image homogeneity (defined as the normalized standard deviation) of the sCBCT and rCBCT are also superior to cCBCT. Visually, an object of ~2% density difference from the background can be discerned in the sCBCT and rCBCT image, but not in the cCBCT image. In this proof-of-principle study, a 350 MU RapidArc®/CBCT plan was delivered in 2.2 minutes. With further optimization, it should be possible to shorten this to ~1.5 minutes.
Conclusion: Our method truly integrates imaging and dose delivery. kV-CBCT with minimal MV scatter can be acquired concomitantly with the RapidArc® with little overhead. Engineering development is needed to further improve the process.

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