AbstractID: 11198 Title: Impact of kVp and Bowtie compensator on cone-beam CT image quality: an Elekta Synergy XVI experience

Purpose: To evaluate the impact of kVp and Bowtie compensator on cone-beam CT image quality using Elekta Synergy XVI system.

Materials and Methods: An XVI system was customarily calibrated at 80, 100, 120, and 138 kVp for various collimation settings. For each kVp, the beam quality and output of the x-ray tube was measured using a 6-cm^3 ion-chamber with a series of tube current (mA) with and without Bowtie filter. Catphan 500 phantom was used for CBCT imaging. For the small FOV and 20-cm length collimation (S20), high-resolution CBCT images were reconstructed with voxel size of 0.5x0.5x0.5 mm^3. Spatial resolution, uniformity, CT-number accuracy and linearity were measured on the Catphan images. Contrast-to-noise-ratio (CNR) was measured using the means (Σ) and standard deviations (σ) in 6-mm diameter circular region-of-interest (ROI) within the polystyrene (PS) and LDPE by the formula of $CNR = (\Sigma_{LDPE} - \Sigma_{PS}) / \sqrt{(\sigma_{LDPE}^2 + \sigma_{PS}^2)/2}$.

Results: The exposure rate with Bowtie filter is linearly proportional to the mAs, increases at a rate of $(kVp)^{2.85}$, and decreased to 73% of that without Bowtie at equivalent kVp and mAs settings. Without Bowtie, the spatial uniformity improves but the CNR deteriorates when increasing kVp at equivalent exposure rates. Application of Bowtie compensator improves the spatial uniformity by more than 11% and increases the accuracy of CT number for soft-tissue materials at all tested kVps. Bowtie compensator also increases the CNR from 1.64 to 1.94 at 100 kVp, but reduces the CNR by ~20% at 120kVp and 138kVp.

Conclusion: Through this clinical investigation, we have found that Bowtie compensator improves the uniformity and CT-number accuracy for soft-tissue materials and may increase the CNR at the low kVp but decrease CNR at the high kVp. In image-guided radiotherapy, using Bowtie with low kVp for small-body and no Bowtie with high kVp for large-body imaging appeared to be optimal settings.