Purpose: To develop an automatic tool for optimal mAs and kVp settings in kVCBCT based on patient CT anatomy and user-defined priorities on normal tissue sparing and image quality.

Methods: An EGS4 Monte Carlo code was employed to calculate 3D dose distributions in patients scanned with kVCBCT at both half-fan and full-fan modes. Absorbed doses to various organs were analyzed. The relationship between absorbed doses, mAs and kVp was studied with phantom measurements and fit with empirical functions. An optimizer tool based on conjugated gradient searching algorithm in multi-dimensions was developed to generate the optimal settings of mAs and kVp based on 3D dose depositions to various organs of individual patient, with consideration of user-defined priorities on normal tissue sparing and image quality. The effectiveness of the optimizer was tested on Catphan and various patient CT anatomies.

Results: Our phantom study indicates that the dose contributions from OBI CBCT half-fan and full-fan modes depend almost linearly on mAs while exponentially on kVp. Empirical functions can be used to reproduce the kVCBCT doses accurately at any allowed mAs and kVp settings. In general, our optimizer recommends much less mAs and kVp than default settings without compromising kVCBCT image quality. Compared to default modes, the optimized modes deposit much less doses, with reduction of 61-66% to the adult and 45-68% to the pediatric patients, respectively.

Conclusions: A novel kVCBCT scan protocol optimizer has been developed to help clinicians choose appropriate mAs and kVp settings for individual patient while maintaining a balance between normal tissue sparing and image quality of kVCBCT scans. With optimal settings, the dose depositions to the patients could reduce by 45-68% on average in comparison to the default without compromising image quality. The developed optimizer could potentially improve radiation safety in medical imaging of both adult and pediatric patients.