

AbstractID: 7773 Title: Analysis on the Use of Megavoltage Cone-Beam Computed-Tomography Images for Dose Calculation

Purpose: To establish a relationship between Hounsfield Unit (HU) from a megavoltage cone-beam CT (MV-CBCT) system and relative electron density, and to assess the error in the dose calculation introduced by CB image artifacts.

Method and Materials: A CT calibration phantom was imaged using different MV-CBCT dose and image filtering protocols. A conversion function from HU to relative electron density relationship for MV-CBCT was developed. The mean pixel value and standard deviation of tissue inserts with known electron densities were analyzed, with the inserts located centrally and peripherally in the phantom. Moreover, to assess the magnitude of error introduced by CB imaging artifacts on the electron densities, the data acquired from placing three tissue inserts in 17 locations throughout the phantom were analyzed using this conversion function. In addition, by simulating tissue inhomogeneities with known and calculated electron densities based on CB, the effects on dose calculations were quantified.

Results: The calculated relative electron densities for the central and peripheral phantom locations were different by 13.1% for trabecular bone, 17.3% for water and 45.7% for lung (exhale). Differences in HU throughout the entire phantom corresponded to a relative electron density interpretation error of up to 17.4% for trabecular bone, 23.3% for water and 71.9% for lung (exhale) were observed. Comparing the dose calculated with known relative electron density, a maximum error of 5.1% for a 6 MV beam traversing a 5.0 cm thick section of lung (exhale) was seen. Variations in measured HU due to different patient dose imaging protocols were insignificant.

Conclusion: The HU to relative electron density conversion varies within the reconstructed volume of the MV-CBCT image. Improved image filtration is needed to reduce errors in calculated relative electron densities and therefore provide more accurate dose calculations specifically for large anatomical volumes.