Purpose:
To report the x-ray beam characteristics of the new x-ray source and to describe the CBCT imaging dose to patients for the TrueBeam™ system.
Methods:
The Monte Carlo code, BEAMnrc, was used to simulate the new tube including its x-ray defining systems and beam hardening filters. Two kV-CBCT scan modes (100 kVp beam for Head scan and 125 kVp for Pelvis scan) available in the TrueBeam™ system were simulated. The simulated realistic incident beams were stored in phase-space files, which were analyzed to obtain the beam characteristics. The kV-CBCT beam output was determined by an ionization chamber in a phantom under specified reference conditions. The simulated realistic beams were then used to calculate dose to patients resulting from CBCT scans. The doses to the patients, as well as image quality using a Catphan-504 phantom, for the TrueBeam and OBI imaging systems were compared.
Results:
The additional kV beam hardening filter in the new x-ray source design removes lower energy photons in the energy spectrum, which in turn results in reduced radiation dose to patient. For a head scan the dose to eye, brain, brain stem, spinal cord are 0.14, 0.15, 0.13 and 0.13 cGy which are approximately 38% lower compared to Standard Head scan in OBI 1.4. For pelvic scan the dose to prostate, rectum, bladder, and femoral heads are 0.8, 0.86, 0.87 and 1.5 cGy, which are approximately 43% lower compared to Pelvis scan in OBI 1.4. In addition the dose to skin from new tube is only half of the doses from OBI 1.4. For the same CTDIw doses, the contrast sensitivity is superior in the TrueBeam images compared to OBI images.
Conclusions:
The newly designed x-ray source is able to reduce CBCT image dose to the patient without compromising image quality.