Purpose: This study demonstrates feasibility and advantages of volume of interest (VOI) cone beam CT (CBCT) imaging performed with an x-ray beam generated from 2.35 MeV electrons incident on a carbon linear accelerator target.

Methods: The electron beam energy was reduced to 2.35 MeV in a Varian 21EX linear accelerator containing a 7.6 mm thick carbon x-ray target. Arbitrary imaging volumes were defined in the planning system to produce dynamic MLC sequences capable of tracking off-axis VOIs in phantoms. To reduce truncation artefacts, missing data in projection images were completed using a priori DRR information from the planning CT set. The feasibility of the approach was shown through imaging of an anthropomorphic phantom and the head-and-neck section of a lamb. TLD800 and EBT2 radiochromic film measurements were used to compare the VOI dose distributions with those for full-field techniques. CNR was measured for VOIs ranging from 4 to 15 cm diameter.

Results: The 2.35 MV/Carbon beam provides favorable CNR characteristics, although marked boundary and cupping artefacts arise due to truncation of projection data. These artefacts are largely eliminated using the DRR filling technique. Imaging dose was reduced by 5-10% and 75% inside and outside of the VOI, respectively, compared to full-field imaging for a cranial VOI. For the 2.35 MV/Carbon beam, CNR was shown to be approximately invariant with VOI dimension for bone and lung objects. This indicates that the advantage of the VOI approach with the low-Z target beam is substantial imaging dose reduction, not improvement of image quality.

Conclusions: VOI CBCT using a 2.35 MV/Carbon beam is a feasible technique whereby a chosen imaging volume can be defined in the planning system and tracked during acquisition. The novel x-ray beam affords good CNR characteristics while imaging dose is localized to the chosen VOI.

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