Minimizing IGRT imaging exposures: kV radiograph vs. kV-CBCT vs. MV portal images

Purpose: Patient positioning can be verified using either electronic portal imaging devices (EPIDs) or kV imaging systems. This study compares the imaging dose from MV, kV and CBCT images.

Methods: The EPID and OBI imaging systems integrated on Varian Trilogy and TrueBeam treatment machines are investigated. The clinical default x-ray protocols in OBI system for kV radiograph image settings were used in this investigation. Experimental measurements with a calibrated ionization chamber are used to determine the Monte Carlo simulated x-ray source output in phantom and to validate calculated patient dose. The Monte Carlo calculated patient dose distributions resulting from image acquisition procedures were analyzed to obtain the organ dose.

Results: For a pelvic image acquisitions, the dose using kV clinical default (Pelvis-AP-Med) anterior–posterior field was 0.077 cGy at surface and 0.015 cGy in prostate, for lateral was 1.5 cGy and 0.06 cGy, respectively, for a kV-CBCT was 1.7 cGy to soft tissues in the imaged volume. For a head image acquisitions, Figure 1 to 3 present the calculated dose distributions for kV radiographs, kV-CBCT and MV portal imaging with EPID. It is seen that by selecting beam angles or using bow-tie filters, organ exposures can substantially reduce when using kV radiographs.

Conclusion: Overall, the radiation exposure to organs was least for kV images, higher for CBCT images and highest for MV images.

![Figure 1](image1.png)

Figure 1. The calculated a pediatric patient dose distributions in color wash for kV head radiographs: 1(a) an AP field (no bow-tie filter), 1(b) a PA field (no bow-tie), 1(c) PA field (with bow-tie), and 1(d) a left lateral field (no bow-tie). Note the dose scale is between 0.001 - 0.1 cGy. Note that the dose to bone is 2-4 times higher than that to soft tissues for kV beams.

![Figure 2](image2.png)

Figure 2. The calculated the same pediatric patient dose distributions in color wash for MV portal images: 2(a) an AP field (6 MV 2 MUs), 2(b) a PA field (2 MUs), 2(c) a left lateral field (2 MU). Note the dose scale is between 1.0 - 2.0 cGy.

![Figure 3](image3.png)

Figure 3. The calculated the same pediatric patient dose distributions in color wash for a Standard Head kV-CBCT scan in axial, coronal and sagittal views. Note the dose scale is between 0.001-2.0 cGy.