Purpose: Removal of the LINAC flattening filter enables a high rate of dose deposition with reduced treatment time. When used for megavoltage imaging, an unflat beam has reduced primary beam scatter resulting in sharper images. In fluoroscopic imaging mode, a higher photon count per image frame yields higher contrast-to-noise ratio. We investigated the effects of an unflat beam on the image quality of megavoltage portal and fluoroscopic images. The impact of flattening filter removal on imaging of moving fiducial markers also was investigated.

Methods: 6MV projection images were acquired in fluoroscopic and portal modes using an electronic flat-panel imager. Portal images also were acquired using XV film. The effects of the flattening filter on the pre-sampling MTF, relative MTF and contrast-to-noise ratio were quantified using the QC3 phantom and tungsten wire. The ability of observers to visualize fiducial markers using flat versus unflat beams also was studied.

Results: The unflat beam had improved contrast resolution, up to 40% increase in MTF contrast at the highest frequency measured (0.75 line pairs per mm). The contrast-to-noise ratio was increased as expected from the increased photon flux. The visualization of fiducial markers was markedly better using the unflat beam enabling visualization of thin gold fiducial markers, the thinnest of which was not visible using the unflat beam.

Conclusions: The removal of the flattening filter from a clinical LINAC leads to quantifiable improvements in the image quality of megavoltage projection images. These gains enable observers to more easily visualize thin fiducial markers and track their motion on fluoroscopic images.