Purpose: Reproducible measurements of CTDI100 are required for ACR accreditation. On CT scanners without a fixed x-ray tube starting angle, the variation of peripheral CTDI100 regularly exceeds the ACR variation criteria of 5%. We investigated the sensitivity of CT peripheral exposure to x-ray tube starting angle.

Methods: Axial scans were performed using a Philips Brilliance 6 CT scanner, varying the x-ray tube starting angle, rotation time, and collimation width. To eliminate table attenuation, exposure was measured in air at isocenter and at 16 cm off-center using a 10 cm pencil ionization chamber. A video camera was used to determine the initial angular position of the gantry at the start of each x-ray exposure. Exposure variation was measured using coefficient of variation (CV) and range.

Results: At isocenter, variation of exposure was minimal (average CV, 0.1%; average range, 0.4%) demonstrating machine output consistency. At 16 cm, however, the variation of exposure was substantial (average CV, 3%; average range, 11%; maximum range, 17%) due to its dependence upon the x-ray tube starting angle, which suggests an asymmetry of the radiation output. Peripheral exposure was independent of collimation width but strongly depended upon rotation time, with increased variation for shorter rotation times (exposure ranges of 17%, 9%, 6% for 0.5, 1.0, 1.5 s, respectively). This data suggests that the dose is delivered for approximately 100 ms longer than the time required for a complete rotation.

Conclusion: Peripheral CTDI100 can vary considerably (~20%) when the x-ray tube starting angle changes. Long rotation times can substantially reduce this variation. In addition, averaging peripheral exposures acquired randomly, or at properly spaced starting angles can further reduce this variation, yielding a reliable average peripheral exposure. Corollary: CT scanners with a fixed x-ray tube starting angle may yield a reproducible systematic error in peripheral CTDI100.