

**Purpose:**

To develop a modified Winston-Lutz test for determining Image Guided Radiotherapy (IGRT) setup accuracy relative to the radiation isocenter.

**Methods:**

A Winston-Lutz cube (Modus Medical Devices) was placed directly on the treatment table and offset from isocenter by 5.0 mm in the longitudinal, lateral, and vertical dimensions. A high resolution Cone-Beam CT (CBCT) was acquired and aligned to the reference CT image. The table was shifted and Anterior-Posterior (AP) and Lateral (LAT) Electronic Portal Imaging Device (EPID) images were acquired, with radiation to cube isocenter agreement determined for each image. This procedure was repeated ten times to determine reproducibility, and then was repeated daily for 51 days. In addition, this test was repeated daily with a random cube shift.

**Results:**

The reproducibility test yielded a mean 3D vector isocenter displacement of  $0.7 \text{ mm} \pm 0.23$  and  $0.26$  for the AP and LAT images, respectively. Maximum deviation was 1.09 mm for the AP images and 1.1 mm for the LAT images. The daily 5.0 mm offset test yielded a mean displacement of  $0.92 \text{ mm} \pm 0.38$  with a maximum of 1.7 mm for the AP images and  $0.95 \text{ mm} \pm 0.47$  with a maximum of 2.0 mm for the LAT images. The random offset test yielded a mean displacement of  $0.68 \text{ mm} \pm 0.31$  with a maximum of 1.54 mm for the AP images and  $0.89 \text{ mm} \pm 0.38$  with a maximum of 2.0 mm for the LAT images.

**Conclusions:**

A modified Winston-Lutz test was developed that helps to quantify the maximum error to be expected for IGRT based setup patients. The test took into account inaccuracies due to IGRT isocenter definition, MV isocenter variation, IGRT software alignment, IGRT couch motions, TPS centroid isocenter definition, CT slice width effects, ROI contouring accuracy, and MLC positioning.