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Design and Implementation of a Custom Phantom for Daily Winston Lutz QA

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Abstract

Objectives:

A commercial cube phantom for daily kV/MV Winston Lutz QA required manual corrections using orthogonal image alignment for optimal agreement. We designed a phantom to enable reliable CBCT-based alignment without the need for user corrections.

Methods:

Alternate phantom shapes were designed using Solid Works and manufactured using a CNC machine. Three phantoms with solid 120 and 150mm diameter spherical acrylic cores were fabricated as two halves with multiple flat outer edges. A ball bearing target was inserted in each sphere. Targets were either Tungsten (6.00mm OD) or Brass (5.56mm or 6.35mm OD) to reduce imaging artifacts. The phantom haves were then glued together. Conformal solid Styrofoam bases were fabricated to elevate the phantoms from the couch. Each phantom was CT scanned using 0.625mm slice thicknesses. CBCT-based Winston Lutz tests were performed to assess artifacts, analysis window/level thresholds and constancy.

Results:

Analysis of the larger phantom with the 5.6mm Brass ball was most sensitive to thresholding due to phantom attenuation. Smaller phantom results were similar with either the larger Brass or Tungsten ball targets, with the later providing slightly better visualization but more image artifacts.

Conclusion(s):

Based on the comparison of the various phantoms, we designed a more robust version of the small phantom with tungsten target. The phantom was modified for routine clinical use by surrounding it with solid Styrofoam and encapsulating it in an ABS shell which is indexed to the couch for efficient workflow.