Purpose:

To evaluate and investigate the feasibility of a new method for validating dose tracking algorithms in deforming tissues using a novel deformable 3D dosimeter.

Methods:

A novel deformable 3D Presage dosimeter is reported consisting of a stretchy polyurethane matrix doped with radiochromic leuco-dye. Two deformable cylindrical dosimeters (6 cm diameter, 5 cm long) were manufactured and irradiated with a checkerboard arrangement of 5 mm square pencil beams created by MLC fields. One dosimeter was irradiated under lateral compression by 33% (6 cm down to 4 cm diameter) to simulate a deformed organ. A second control dosimeter was irradiated with the same checkerboard pattern but without deformation applied. High-resolution 3D dose distributions (isotropic 1 mm resolution) were obtained by optical-CT imaging. Physical dose deformation was quantified by comparing checkerboard pencil beam shapes and positions in the deformed and control dosimeters.

Results:

Deformation of dose in the deformed dosimeter was clearly visible in all 3 dimensions. The deformed checkerboard dose pattern showed expansion of 16% - 46% along the axis of compression, with higher expansion observed in the central regions of the dosimeter. Perpendicular to the compression axis, the dose pattern contracted by 7% - 13%. Peak dose changes of -6% and +30% were observed parallel and perpendicular to the compression axis respectively. Dose response was linear from 0 - 8 Gy.

Conclusions:

Dose tracking was successfully quantified in a novel deforming 3D dosimeter. This capability has potential as a powerful new method for validating deformable dose tracking and registration algorithms.

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