Purpose: To develop radiochromic hydrogels contained in latex balloons as a model for 3D dosimetry in deformable tissue.

Methods: Films of latex solution were thermally cured to form thin sheets of transparent rubber. Spheroid, elastic dosimeters were made by filling adaptor tubes sealed at one end by circular rubber sheets with radiochromic hydrogel. These dosimeters were evaluated for optical and mechanical properties and dosimetric performance. Dosimeters were scanned with a fast 3D optical cone beam computed tomography system and dose distributions were reconstructed with isotropic 0.25 mm sized voxels. Gels were irradiated in a water tank to a uniform 3 Gy dose or by an array of 5 mm square beamlets in a grid pattern, with the dosimeter in either relaxed or deformed state. Four percent gelatin gels were employed in the study and dosimeter rigidity was adjustable by filling balloons with more gel. Dosimeters were maintained at a temperature of 20° C throughout the experiments. Deformed gels were allowed to return to the relaxed state for 30 minutes while the radiochromic reaction completed prior to CT scanning.

Results: Ferrous - xylenol orange - gelatin hydrogels in latex balloons exhibited similar auto-oxidation rates and dose sensitivities to samples contained in rigid plastic vessels. The thin-walled latex balloons provided excellent optical transmission performance allowing accurate dosimetry to within 1 mm of the balloon wall. Uniform irradiations resulted in uniform dose reconstructions for both the relaxed and deformed dosimeters. Deformed gel irradiated with the beamlet array and scanned in relaxed state demonstrated ability of dosimeter to record 3D dose deformation patterns.

Conclusions: The elastic properties of transparent films and hydrogels can be combined to produce deformable 3D radiochromic dosimeters compatible with optical CT scanners. These dosimeters can be used to validate multi-fraction dose accumulation algorithms based on image warping algorithms.

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