PRESENTATION TITLE
Polymer gel-based measurements of radiation isocenter accuracy in magnetic fields

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ABSTRACT

Purpose: The introduction of magnetic resonance (MR)-guided-radiation therapy (RT) devices requires new quality assurance (QA) methods. One important aspect is the development of new methods for machine QA-procedures, including especially the simultaneous measurement of the radiation and imaging isocenter. Polymer dosimetry gels (PG) may offer a way to perform both tests as PG visible in MR imaging. Additionally PG may allow for online 3-dimensional (3D) evaluation, however, it has to be shown first that PG reveals comparable results as the conventionally applied films. For this purpose, we demonstrate the feasibility of a polymer gel (PG)-based isocenter accuracy test with and without magnetic field. In addition, we demonstrate that the polymer gel can be evaluated shortly after irradiation.

Materials & Methods: Experiments were performed with both EBT3 films (ISP, Wayne, USA) and PAGAT polymer gel (PG). The PG consists of monomers embedded within a gelatine matrix. After irradiation, the gel polymerizes locally and alters its local relaxation rates $R_2$ depending on the absorbed dose. A star shot measurement was performed within an electro magnet (AGEM 5520, Schwarzbeck Mess-Elektronik, Schönau, Germany) with and without application of a magnetic field of 1 T. Due to the positioning of the electro magnet, the gantry rotation was limited to angles between 260° and 80°. To obtain a comparable beam arrangement, the irradiation was performed in two steps: After irradiating the upper hemisphere (gantry angles of 288°, 0° and 72°), the gel containers and films were rotated manually by 180° and the remaining beams were irradiated also from the upper side to mimic an
irradiation from gantry angles of 216° and 144°. The PG was evaluated the by MR imaging (3 T Biograph mMR, Siemens Healthineers, Erlangen, Germany). Both dosimeters were evaluated with the commercial software Mephisto (PTW, Freiburg, Germany).

**Results:** For the measurements inside the electromagnet the iso-circle radii showed a comparable increase from 0.39 ± 0.01 mm to 1.37 ± 0.01 mm for the film and from 0.44 ± 0.02 mm to 0.97 ± 0.02 mm for the PG-measurements, when a magnetic field of 1T was applied. No significant changes over time for the radius of the iso-circle was found.

**Conclusions:** This study demonstrates that evaluation of the polymer gel directly after irradiation is feasible, if only geometrical parameters are of interest. This allows using polymer gels for star shot measurements to evaluate the radiation isocenter accuracy with comparable accuracy as with radiochromic films. For future applications within an MRgRT-device a special QA phantom is being designed, which allows simultaneous measurement of the radiation and imaging isocenter accuracy as well as spatial image distortions in the MR images in 3D.