Purpose: Complex treatment methods such as rotational intensity modulated radiotherapy (rIMRT) offer highly conformal dose delivery but are at risk of being compromised due to target motion. Dynamic MLC tracking has been developed to compensate for target motion online. Due to the complex 3D patterns of tumour motion, tracking would benefit from a full 3D dosimetric verification. In this study we have therefore investigated the use of 3D dosimetry - with gels and optical tomography - for measuring the effect of tracking on 3D dose distributions with the use of a clinically measured prostate trajectory.
Methods: Two normoxic polyacrylamide gel dosimeters were irradiated with the same prostate rIMRT treatment plan, delivered with and without tracking while placed on a motion stage that reproduced a patient measured prostate trajectory. A reference gel dosimeter was irradiated without motion or tracking. Dynamic MLC tracking was performed using an electromagnetic transponder system (RayPilot, MicroPos AB, Gothenburg Sweden). After experiments the 3D dose distributions in the two motion experiments were read-out using an optical CT scanner and compared to the stationary reference dosimeter using 3 %/3 mm gamma analyses.
Results: 2D 3%/3mm gamma analyses were performed at equidistant slices separated by 1 cm in the transverse plane and the coronal plane of the 3D dosimeters. The weighted average gamma fail-rate was improved from 37% to 14% (transversal plane) and from 30% to 9% (coronal plane) by tracking compared to treatment without tracking.
Conclusions: Optical 3D dosimetry is a valuable tool to quantify the impact of motion and motion compensation on the delivered dose distribution to a moving target. Improved knowledge about the dose distribution is obtained due to (i) the three-dimensional nature of the measurements and (ii) the high resolution compared to competing techniques.