

AbstractID: 9277 Title: 4D Planning: dose calculation that accounts for moving beams and tissue deformation

Purpose: To evaluate the ability of 4D Treatment Optimization and Planning, which is a recently available feature in the MultiPlan® Treatment Planning System for 4D treatment planning for motion tracking with the CyberKnife® Robotic Radiosurgery System, to calculate a dose distribution that takes into account both beam movement due to respiratory motion and soft tissue deformation.

Method and Materials: A phantom was developed for 4D planning validation, containing a target that exhibits periodic motion driven by a motor, and a critical structure adjacent to the target. A 4D CT scan of the phantom in motion was obtained, and a treatment plan created on this 4D CT scan using MultiPlan with the 4D Planning module. The target has fiducials embedded in it, and Synchrony® Respiratory Motion Tracking System was used so that the treatment beams followed the target motion. Radiochromic film was placed in the critical structure and the treatment plan was delivered. The film dose after treatment was compared with that calculated by MultiPlan using both the static dose calculation (3D dose) and that calculated using the 4D Planning module. The 4D Planning module uses deformable registration and information about beam movement to calculate a dose distribution that takes into account both target movement and tissue deformation during treatment (4D dose).

Results: For the 3D dose in the coronal film, 64.4% of pixels had a disagreement of 3% or less between measured and predicted dose; for the 4D dose distribution, 97.6% of pixels had a disagreement of 3% or less. Using a Gamma function with a passing criterion of 5% dose difference or 3mm distance to agreement, 94.9% of pixels pass for the 3D dose and 100.0% of pixels pass for 4D dose.

Conclusion: The 4D Planning module accurately calculated dose in this phantom test for a moving target..