AbstractID: 9434 Title: Simulation of intrafraction motion and overall geometrical accuracy of a frameless intracranial radiosurgery process

Purpose:

Evaluate the clinical accuracy of an image-guided frameless intracranial radiosurgery system including the positioning accuracy of the 6D ExacTrac System. A novel method was evaluated to prospectively determine an optimal PTV margin.

Method and Materials:

The overall system isocentric accuracy was tested with a rigid anthropomorphic phantom containing a hidden target. Additionally, a Rando® Phantom was utilized for testing the positioning uncertainties in the 6D ExacTrac System where tilts and rotations were physically applied and then adjusted by the Robotic Table Top and ExacTrac Software. Intrafraction motion was simulated in five healthy volunteers immobilized with head and shoulders reinforced thermoplastic masks. The subjects were placed in a treatment position for 15 minutes (the maximum expected time between repeated isocenter localizations) and the six-degree-of-freedom target displacements were recorded with high frequency by tracking infrared markers. The markers were placed on a customized piece of thermoplastic secured to the head independently of the immobilization mask.

Results:

The hidden target test confirmed overall system isocentric accuracy of $\leq$1 mm (total 3D displacement). The final accuracy of the rotational setup of the cranial isocenter was 0.14 ± 0.09 degrees Yaw, -0.33 ± 0.17 degrees Roll and -0.43 ± 0.08 degrees Pitch. The subjects exhibited different patterns and ranges of head motion during the mock treatment. The total displacement vector encompassing 95% of the positional points varied from 0.4 to 2.9 mm.

Conclusion:

Pre-planning motion simulation with optical tracking was tested on volunteers and appears promising for determination of patient-specific PTV margins. Further patient study is necessary and is planned. In the meantime, system accuracy is sufficient for confident clinical use with 3 mm PTV margins.