AbstractID: 3684 Title: Measured Dose Gradients for Extracranial Stereotactic Radiosurgery

Purpose:
The main limiting factor in determining the amount of radiation dose that can be prescribed to a vertebral metastasis is the dose to the spinal cord. The goal of this work was to measure the dose gradient for a helical tomotherapy delivery system.

Method and Materials:
The spinal cord organ at risk (OAR) was a cylinder 10-mm in diameter that extended 5-cm superior-inferior. The PTV was a half annulus 25-mm thick that also extended 5-cm superior-inferior. Five benchmark test cases were created with the separation between the PTV and the spinal cord set to 2-mm, 4-mm, 6-mm, 8-mm, and 10-mm. Although the gap between the PTV and the OAR was variable, the thickness of the PTV was held constant. Relative dose measurements were made using calibrated film placed in the phantom. The dose gradient was measured from the slope of anterior-posterior profiles in the gap region between the PTV and the OAR.

Results:
For a 10-mm gap, the calculated maximum OAR dose was 7.5 Gy (25%) for a prescribed PTV dose of 30 Gy. The calculated maximum OAR dose increased to 21.3 Gy (71%) with a separation of 2-mm. A linear regression yielded a dose gradient of 10.6% / mm ($R^2 = 0.988$). Typically, dose gradients in excess of 5% / mm decrease the PTV uniformity index below the clinically acceptable 20%. However, the benchmark tests in this study yielded a dose gradient in excess of 10% / mm while maintaining PTV uniformity indices of 4, 10, 11, 11, and 11% respectively for the 10, 8, 6, 4, and 2-mm PTV-to-OAR separations.

Conclusion:
Helical tomotherapy benchmark test cases delivered to a cylindrical phantom indicated that the delivered dose gradient could be as high as 10% per millimeter while providing PTV uniformity of 15% or less.