Investigation of 3D Dosimetry for an Anthropomorphic Spine Phantom

Innovation/Impact: The ability of 3D dosimetry to obtain a large amount of dose information in a single irradiation can be advantageous in the clinic. For areas which dose margins must be closely monitored, such as spinal metastases, the option to evaluate the dose volume rather than a single plane can allow the physicist to check along the high dose gradients and any other regions of interest rather than chosen planes usually through the target center.

Introduction: The Radiological Physic Center (RPC) has an anthropomorphic spine phantom which currently uses radiochromic film and thermoluminescent dosimeters (TLD) to evaluate spinal metastases treatments. The target is located anterior to the vertebrae with the spinal cord and esophagus as avoidance structures. Two TLD are located in the target while radiochromic film bisects the center of the target in the sagittal plane and at the matching edge of the vertebra and the target in the coronal plane. This allows for evaluation along only these two planes. A 3D dosimeter encompassing the entire section of the spinal column allows for complete visual evaluation of the dose volume delivered and the ability to choose 2D planes for further analysis. For this study, we are using PRESAGE®, a solid radiochromic plastic and an optical-CT system for readout.

Methods and Materials: A second dosimetry insert for the phantom was created to hold a specially molded PRESAGE® dosimeter which matches the location of the TLD and film in the original insert. The phantom was CT imaged with each insert and the images were imported to the treatment planning system (TPS). An intensity modulated radiation therapy (IMRT) plan was created with the prescription of 6 Gy to 90% of the target with appropriate constraints to the normal structures. The plan was delivered to the phantom twice; once with the TLD and film insert and once with the 3D dosimetry insert. The film and PRESAGE® were scanned on a CCD microdensitometer and an optical-CT system, reconstructed to a 2 mm slice width, respectively. The measured dose distributions were compared to the treatment plan calculated dose distribution using RPC in-house developed software or the Computational Environment for Radiotherapy Research (CERR)². Film and PRESAGE® dose profiles were taken across several planes and compared for agreement. The distance to agreement (DTA) between the measured data and treatment plan, within the high dose gradient region, was quantified.

Results: The dose profiles show agreement within 2 mm in the anterior-posterior direction and with 1 mm in the superior-inferior direction using the PRESAGE®. The film agreed within 2 mm across all profiles. Representative dose profiles are shown below.

Conclusions: Preliminary results show PRESAGE® shows potential as a dosimeter for RPC phantom studies. Differences in the DTA between the TPS and the measured dose were within 2 mm for all profiles for the standard film dosimetry and the 3D dosimetry. Future work will add markers to the PRESAGE® insert to allow for a reproducible registration in CERR and a dose calibration will be created.

References: