AbstractID: 6954 Title: Dose Painting With Intensity Modulated Proton Therapy and Intensity Modulated X-ray Therapy: a Comparison

Purpose: To compare intensity modulated proton therapy (IMPT) versus intensity modulated x-ray therapy (IMXT) for the delivery of nonuniform dose prescriptions based on hypoxia-imaging, so-called dose painting.
Materials and Methods: IMXT delivered with helical tomotherapy (HT) was compared to IMPT delivered with spot scanning (SS) and distal gradient tracking (DGT). The novel DGT method places beam spots where dose prescription gradients occur along the pencil beam axis. Fundamental dosimetric properties of each modality were assessed by creating optimized plans for 144 variations of a cylindrical phantom with six boost regions embedded inside a base tumor region. Clinical cases with biologically conformal dose prescriptions based on PET with the ^{61}Cu-ATSM hypoxia imaging radiopharmaceutical were planned. The effects on the nonuniform dose distribution of delivering IMPT on a 180º arc versus equi-spaced beams spread over 360º were investigated.
Results: Phantom studies showed that nonuniform dose plan quality for tomotherapy, SS, and DGT, was similar, but DGT plans were most sensitive to phantom size and boost region proximity. IMPT reduced normal tissue integral dose by a mean factor of around two relative to IMXT. Clinical dose deviations from the prescription were comparable for all modalities, but arc IMPT deliveries markedly reduced normal tissue dose and improved critical structure sparing without compromising the dose distribution in the tumor.
Conclusions: In the target volume, IMXT and IMPT deliver comparable nonuniform dose distributions. IMPT offers improved integral normal tissue dose and sparing of critical structures over IMXT, as was the case for uniform dose deliveries. DGT reduces required beam spots by a factor of about three relative to SS. IMPT dose painting will require similar management of intrafractional patient motion as for IMXT, with the additional consideration of proton spot placement uncertainty.

TR Mackie has a conflict of interest due to financial interest in TomoTherapy, Inc.