Purpose:

To explore the correlation between spatial dose distribution and toxicity of normal tissue by mapping 3D dose distribution onto a reference patient.

Methods:

In order to facilitate the direct correlation between dose to a certain tissue sub-volume and toxicity, 3D dose distributions of a patient cohort are deformed onto a single reference patient using deformable image registration. Spatial Spearman rank correlations between warped dose and toxicity are then computed on a point-by-point basis over the entire voxel space of the reference patient. We illustrate this approach using a cohort of 37 right-sided H&N cancers of the oropharynx regarding the endpoint of trismus. Patients were treated with definitive IMRT and concurrent chemotherapy with a prescription dose of 70 Gy between Jan. 2004 and April 2009 at MSKCC with a median follow-up time of 34 months (range, 6-68). 12 patients developed trismus (Grade ≥1). Dose volume histograms (DVH) of the mastication muscles were also exported to perform logistic regression.

Results:

The standard logistic regression model based on DVH derived parameters for contoured muscles provided a moderate Spearman correlation (Rs=0.45, p<0.05). Meanwhile, examining the 3D Spearman map reveals a region with high correlation (Rs=0.58, p<0.001). Interestingly, a close up view shows that this potentially radio-sensitive region is located on the contralateral side at the attachment point of the medial and lateral pterygoid muscles with the pterygoid plate.

Conclusions:

This study demonstrates the feasibility of studying the spatial correlation between dose and toxicity in normal tissues. The validity of this method was demonstrated in H&N patients. This technique preserves the spatial information of the dose distribution and provides an unbiased approach to identify critical anatomic structures since it does not require prior assumptions about the organs at risk. In addition, this method is generic and can be extended to study other complication endpoints.

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