Quantifying the Effects of Radiation Therapy Fractionation Scheme on Dose Response Modelling

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INTRODUCTION

- Previous works have shown regions of high-functioning lung tissue are more susceptible to radiation damage [1]
- In order to create quality functional-avoidance treatment plans, accurate prediction of post-radiation therapy (RT) ventilation damage is necessary
- Dose response models have been developed to predict post-RT damage, but did not consider the impact of fractionation scheme/ treatment volume [2]

AIM

The purpose of this work was to quantify the effects of radiation therapy fractionation scheme on modelling post-RT ventilation changes due to radiation damage.

METHOD

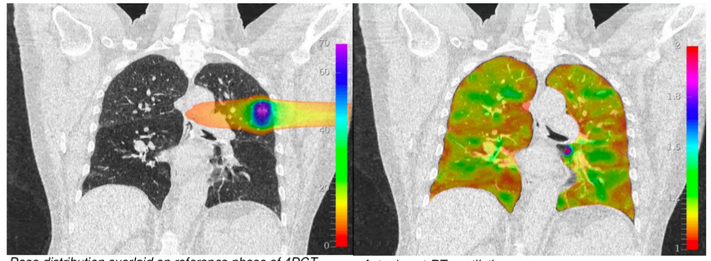
- 30 standard fractionation subjects & 23 hypo-fractionated stereotactic body radiation therapy (SBRT) subjects
- Three dose response models were created using 4DCT-derived ventilation maps using the following subjects:
  - 18 subjects from each fractionation scheme
  - 18 SBRT subjects
  - 23 standard fractionation subjects
- Polynomial models were fit to each of the three different groups of subjects with independent variables being the pre-RT Jacobian values and dose to each voxel
- Gamma analysis was performed on each model for validation using the remaining subjects in each group
- Additionally, true positive rate (TPR) and accuracy were also quantified

RESULTS

- The gamma pass rate, accuracy, and TPR for each of the models are presented in the table
  - These values across all models were similar with the exception of the TPR for the SBRT-only model
    - This may be due to the relatively smaller treatment volumes used in SBRT compared to standard fractionation
- The figures show the actual and predicted post-RT ventilation map for each of the models
- All three of the predicted maps shown tend to predict less damage (or less decrease) in lung ventilation compared to the actual post-RT ventilation map

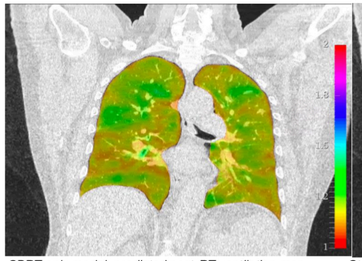
Table summarizing the accuracy, gamma pass rate, and TPR of each dose response model

	Model Type		
	SBRT	SFX	Mix
Accuracy	73.5%	77.8%	77.5%
Gamma	54.9%	56.1%	55.9%
TPR	3.4%	30.9%	30.0%



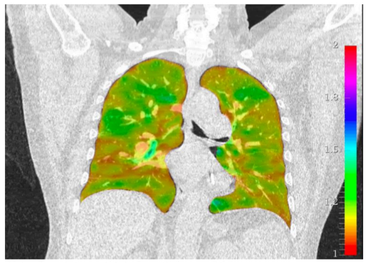
Dose distribution overlaid on reference phase of 4DCT

Actual post-RT ventilation map



SBRT-only model, predicted post-RT ventilation map

Standard-fractionation-only model, predicted post-RT ventilation map



Mixed model, predicted post-RT ventilation map

CONCLUSIONS

- It was shown there was **no significant difference** between predictive dose response models using subjects from different fractionation schemes
- This result suggests there may be no need for multiple dose response models for different fractionation schemes
- Each model predicted less damage than what truly occurred suggesting there are additional damage mechanisms that must be included in the model

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