MRI-Defined Tumor Volume Change During SBRT for Oligometastatic or Unresectable Malignancy of the Central Thorax

L.E. HENKE, 1 D. PRZYBYSZ, 1 R. KASHANI, 1 O. GREEN, 1 C. ROBINSON, 1 J. BRADLEY. 1

1Siteman Cancer Center, Washington University School of Medicine/Barnes Jewish Hospital, Department of Radiation Oncology (St. Louis, MO)

INTRODUCTION
Stereotactic body radiotherapy (SBRT) is an attractive modality for the definitive treatment of oligometastatic or unresectable primary lung malignancies. Previous attempts to deliver dose-escalated treatment to the central thorax have resulted in prohibitive levels of toxicity. 1 Proximity of the tumor to adjacent organs-at-risk (OAR) such as the esophagus, great vessels, heart, and proximal bronchial tree may limit safe delivery of a sufficiently ablative dose. Daily low-field MR setup imaging offers improved segmentation of critical soft-tissues of the central thorax and is now feasible with a novel magnetic resonance image-guided radiotherapy (MR-IGRT) treatment system. 2 The ability to adapt to tumor response during treatment using MR-IGRT technology may improve OAR sparing and/or allow dose escalation.

OBJECTIVES
1. Characterize on-treatment tumor volume size using a magnetic resonance image-guided radiotherapy (MR-IGRT) treatment system.
2. Qualitatively evaluate the degree of daily interfraction variation in gross tumor volume (GTV) over the course of treatment.
3. Identify a potential time-point for plan adaptation to minimize dose to organs-at-risk and/or enable dose escalation to the remaining primary tumor.

METHODS
• 11 patients with unresectable primary or oligometastatic malignancy of the central thorax were treated at our institution with extended fractionation SBRT using a dedicated clinical MR-IGRT system (ViewRay Inc. Oakwood Village, OH).
• Treatment regimens consisted of stereotactic body radiation therapy to 60 Gy in 12 fractions (n=8) or 62.5 Gy in 10 fractions (n=3).
• At each treatment fraction, low-field (0.35 Tesla) MR setup imaging was acquired as part of routine clinical practice.
• A daily GTV was retrospectively defined on MR image sets for all patients at each of 10 or 12 fractions, using initial GTVs from CT simulation as a template.
• Organs-at-risk, including the esophagus, carina, heart, and normal lung were re-segmented on daily set-up images by study physicians.
• Daily tumor volumes were then recorded and compared for each patient to evaluate for interfractional change in tumor volume.

RESULTS
As represented by an example patient in Figure 1, all patients demonstrated on-treatment reduction in MRI-defined GTV (Figure 2).
• Average reduction in tumor size from treatment initiation to completion of therapy was 51.0% (median 52.1%) and ranged from 30.5-70.8%.
• At a mid-treatment time point of fraction six, average reduction in GTV size was 38.2% (median reduction in GTV of 34.8%).
• Linear correlation across median values at each time point suggested a consistent decline in gross tumor volume over time of approximately 4% per day (Figure 2).
• The most pronounced changes in MR-defined daily tumor volume occurred between the 5th and 6th fractions (Figure 2).

CONCLUSIONS
We demonstrate a novel means of defining and analyzing tumor volume changes during stereotactic body radiation therapy for tumors of the central thorax. GTV segmentation was easily achieved using daily low-field MR setup imaging. Tumor volume decreased considerably during treatment for most patients undergoing lung SBRT.

In particular, at a time point of fraction six, the average patient’s GTV was over one-third smaller than tumor size at initiation of therapy. This suggests a potential opportunity for and benefit of mid-treatment adaptive re-planning. The dosimetric impact of this degree of MRI-defined tumor volume change during the course of therapy has yet to be assessed.

However, adaptive planning during the course of SBRT may be dosimetrically advantageous for sparing of surrounding critical structures. Such adaptive re-planning might provide a window of opportunity to improve the therapeutic index of SBRT, particularly for disease involving the central thorax where dose-escalated therapy has previously been limited by excess toxicity.

REFERENCES