Purpose:

To investigate the necessity for adaptive radiation therapy (RT) in lung cancer IMRT treatments by quantifying tumor changes during radiotherapy and the associated impact on target, lung and esophagus.

Methods:

As part of an IRB-approved lung dose escalation study, contrasted CT scans were acquired on 15 patients prior to RT and in the 2nd and 5th week of treatment (total dose=58-70 Gy, 2Gy/fraction). Target, lung and esophagus volumes were segmented in all CT datasets. The original plan was recomputed on the subsequent CT sets and doses were accumulated by deformable registration to approximate the actual delivery. Five patients with the largest tumor shrinkage were selected and re-planned on the 2nd and 5th week CT sets. The plans were summed to mimic adaptive radiation therapy. Comparisons were made between the approximated actual treatment, summation of the re-optimized plans, and the original plan. Comparison metrics included QUANTEC dose parameters, equivalent uniform dose (EUD), maximum dose and target coverage (unless otherwise stated, all percentage changes in results are with respect to the original plan, averaged over all patients).

Results:

The approximated actual delivery had significantly increased lung dose-volume/EUD (V5 =8.19%, V20 = 4.14%, EUD = 5.95%). Tumor shrinkage-induced esophageal volume outside the originally segmented volume (3.4%-101.8%) was significant. Elevated esophagus EUD (7.27%) and spinal cord maximum dose (6.7%) were observed in most patients. PTV/GTV volumes receiving 100% of prescription dose decreased (week 2/5 PTV = -10.0%/-6.88%, week 2/5 GTV = -6.7%/-4.1%), along with slightly increased dose to the highest 1% of volume. Compared to the approximated actual delivery, re-optimized plans overall showed superiority in lowered dose to the esophagus (V35=-40.32%, EUD =-13.42%), lungs (V5=-4.18%, V20=10.66%) and spinal cord (Dmax=-22.98%).

Conclusions:

RT-induced esophageal volume displacement and increased lung dose during treatment are significant, warranting re-plan in cases where large tumor changes are expected.