Purpose: To determine whether the accuracy of CBCT based IGRT and ART lung SBRT treatments may require extra quality assurance (QA) steps.

Methods: During CBCT Rando phantom acquisition we detected an unexpected ~2° image rotation when comparing the CW and CCW acquired scans. Misregistered angular coordinates may result in a rotated reconstructed image and the target localization may lead to an under- or over-dosage of the target volume (TV) and organs at risk (OARs). The effect of image rotation on CBCT-guided lung SBRT was retrospectively examined in a group of six patients treated at our institution. Patient CT sets were rotated by 1, 2, and 3°. Treatment plans were recalculated using these rotated images to examine changes of dose-volume histogram indicators for IGRT and ART guided treatments. C++ simulations were run to evaluate the effect of CBCT image rotation.

Results: We determined through mathematical analysis that the dose coverage of the TV is dependent on its shape, location and orientation relative to isocenter. Dosimetric evaluation of lung SBRT patients showed that even for $1 < \theta < 3^\circ$, changes in D95 to the PTV were from $2.3 \pm 2.1$ to $11.5 \pm 3.9\%$ for IGRT and from $8.5 \pm 8.4$ to $16.6 \pm 8.0\%$ for ART. Significant changes were also detected at critical structure level.

Conclusions: When IGRT and ART are employed for lung SBRT treatments, significant dosimetric changes may result from the rotation of CBCT image data sets. The extent of alterations in dose indicators depends on both the shape of the TV and its relative location to isocenter. Based on our results, angular alignment of CBCT to $<1^\circ$ is essential in maintaining accurate dose delivery of IGRT and ART based lung SBRT treatments.