Purpose: Steep dose gradients and high dose per fraction in stereotactic ablative radiation therapy (SABR or SBRT) necessitate highly accurate tumor localization. This study evaluates interfraction shifts, as defined by couch correction analysis, and investigates the effect of tumor location and internal target volume (ITV) on these shifts. In addition, residual errors associated with post-CBCT correction and their dosimetric consequences were quantified.

Methods: Daily free-breathing (FB) CBCT images used for daily localization of 78 patients with non-small cell lung cancer were retrospectively evaluated. Among the population, 39 patients also received pre-treatment kV images after CBCT alignment. ITV interfraction displacement was evaluated by matching the CBCT and the FB helical CT images, and setup errors were quantified using orthogonal kV images. Associations between ITV location and interfraction motion were studied by categorizing tumors into the following locations: chest-wall seated (CWS) and island, peripheral, central, or upper, middle and lower. Dosimetric consequences for the patient with the largest setup error were explored.

Results: ITV interfraction motion included the mean of the systematic error, $\mu_{\text{inter}}=(-1.4, 2.0, 1.6)$ mm, standard deviation (SD) of the systematic error, $\sigma_{\text{inter}}=(2.1, 4.2, 2.9)$ mm, and SD of random errors, $\sigma_{\text{inter}}=(2.2, 3.2, 3.6)$ mm. No significant associations were observed between interfraction shifts and tumor location or volume. Using CBCT for image guidance reduced the observed errors to $\mu_{\text{setup}}=(-0.3, 0.1, 0.0)$ mm, $\sigma_{\text{setup}}=(0.6, 0.6, 0.4)$ mm and $\sigma_{\text{setup}}=(1.2, 0.7, 0.7)$ mm. Dosimetric consequences for the patient with the largest setup error were explored. It was shown that a 3.0 mm setup margin was sufficient to provide greater than 95% dose coverage to the ITV.

Conclusion: CBCT image guidance reduced setup errors significantly such that 2-3 mm, population-based, setup margins provided proper dose coverage to the ITV. Further investigation of inter-and intrafraction error classification by tumor location is warranted.