Purpose: With no stable landmarks available for localization, a 'virtual isocenter' or surrogate landmark near the target can be used for image guidance. However, using a virtual isocenter in ExacTrac has not been thoroughly validated. This study evaluates its target localization accuracy and investigates the impact of two different couch correction sequences.

Methods: A CT scan was acquired on an anthropomorphic thoracic phantom with a 2mm-diameter ball bearing (BB) marker implanted in the lung region. A treatment plan was created with isocenter placed at the BB center, and exported to ExacTrac. In ExacTrac, a virtual isocenter was placed on a spine vertebral body where three translational shifts (8.8cm laterally, 1.5cm longitudinally and 6cm vertically) were present. A series of couch rotations (+/-3 degrees, 1 degree increment) was intentionally applied to simulate angular setup variations. For each rotation, two stereoscopic x-ray images were acquired and fused using the ExacTrac 6D registration algorithm. Calculated shifts were applied using two sequences: (1) automatic 5D corrections (three translations/two robotic couch rotations) followed by manual couch rotation; (2) manual couch rotation then automatic 5D corrections. After each ExacTrac localization, orthogonal (anterior-posterior and right-lateral) portal images were acquired to quantify BB center deviations from the radiation isocenter as an indicator of residual error.

Results: Minimal difference between investigated table correction sequences was observed. Average translational deviations between the BB and radiation isocenter (mean+/-1SD) were 0.3+/-0.3mm and 1.0+/-0.2mm for lateral and vertical axis respectively. Longitudinally, the deviations were 0.8+/-0.4mm from the anterior-posterior image and 0.1+/-0.3mm from the right-lateral image. The systematic difference (0.7+/-0.1mm) between the two may have been attributed to gantry sagging during rotation.

Conclusions: ExacTrac system successfully corrected angular shifts using the virtual isocenter method in a rigid phantom setup. The sequence of couch correction did not influence the localization accuracy. Further patient study is warranted.