Purpose/Objective(s): Cone beam CT (CBCT) imaging is a powerful tool to assist in accurate patient positioning before radiation treatment (RT). Due to the high dose gradients employed in stereotactic RT (SRT) planning, the need to keep setup positioning within the planning margins is imperative. Due to long treatment times and patient anxiety, patient positional constancy during spine SRT is a serious concern. We evaluate the setup accuracy and reproducibility of SRT based on CBCT scans recorded after the positional correction for treatment and after the SRT delivery. Positional pre-treatment correction residuals and intrafraction positional changes are studied along with the treatment total positional error.

Materials/Methods: A total of 27 patients were immobilized within an extra-cranial immobilization device (Body Fix) and underwent a planning CT. At the time of treatment, the target was localized in 3D using CBCT and rigid body (bony) registered to the reference CT. The target position is recorded as the pre-correction position. Based on the first CBCT scan, an affine correction is applied via the treatment table (for coarse adjustments) followed by fine corrections using the Hexapod (6-D) robotic couch system (capable of performing 3 axis translations and rotations). The new position is verified via a second CBCT registration with the reference CT and recorded, followed by SRT treatment initiation. The residual error needs to be below the 50% of the setup planning margins (translations < 2.0 mm and rotations < 1°) or another affine correction and a subsequent verification CBCT are performed. In such cases (3 of 27 patients), the final CBCT before treatment provides the residual error. A post-Tx CBCT scan is performed at the end of the treatment. Typically, total treatment times range from 45-60 min including (20-25 min of beam-on time + 3 CBCT scans + related image processing and analysis).

Results: For the 27 spine SRT treatments, the (mean ± SD) of the translation residuals was largest along the SI direction: (Lat, SI, AP) = (0.34 ± 0.31, 0.45 ± 0.5, 0.34 ± 0.27) mm. The rotation residuals are the largest around the AP direction: (Lat, SI, AP) = (0.3 ± 0.4, 0.5 ± 0.4, 0.5 ± 0.5)°. Post-Tx total positional errors were (0.65 ± 0.62, 0.78 ± 0.68, 0.34 ± 0.27) mm and (0.5 ± 0.5, 0.8 ± 0.8, 0.7 ± 0.7)°. Intrafraction motion is evaluated by the absolute difference between post-Tx total errors and pre-Tx residual errors : (0.64 ± 0.61, 0.63 ± 0.57, 0.70 ± 0.80) mm, (0.4 ± 0.4, 0.7 ± 0.7, 0.5 ± 0.4)°.

Conclusions: In this evaluation of spine SRT, the intrafraction positional error has been shown to be consistently in the sub-millimeter range, proving that a 2 mm setup planning margin is conservatively appropriate for a frameless spine SRT technique provided 3D image guidance is utilized.

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