Purpose: To develop a whole-procedure Winston-Lutz (WL) test method to determine the full system accuracy of a vacuum-assisted bite-block based frame system for multi-fraction Gamma Knife radiosurgery in reference to standard metal frame based single fraction delivery.

Methods: A patient-specific bite-block frame was first modified to incorporate a pin mark and a slanted film holder. Using actual treatment protocol, a frame-indexed CT study was obtained and a treatment plan was developed accordingly. Then a film was placed and exposed to the pin-point position as identified per plan. To minimize signal noise for the exposed film where isodose distributions were mostly non-spherical, a band of peripheral dose distribution in the range of 40%-60% of central dose was extracted and then the average center-of-mass position from the dose band was measured and compared against the pin-point position. The test was carried out for initial system commissioning as well as patient-specific quality assurance measurements.

Results: Unlike traditional WL test where the border of an exposed field must be precisely demarcated, our current procedure eliminates such requirement via averaging a peripheral band of measured point cloud. The final result was more robust against random noises and artifacts associated with scatter radiation and signal processing. The mean variation against varying bandwidth and repeated film exposures was found to be within 0.05±0.11 mm. For the initial 21 independent treatment deliveries as tested at our institution, the overall system accuracy was 0.36±0.11 mm, which matched excellently with 0.29±0.19 mm as measured for a rigid metal frame.

Conclusions: A robust CT-based Winston-Lutz test procedure was developed for a multi-session bite-block based stereotactic frame system. Submillimeter physical accuracy was established for such a system in a clinical setting.