Purpose: To investigate the use of the Lucy ® Stereotactic Phantom (Standard Imaging, Inc.) for Gamma Knife Perfexion radiosurgery quality assurance of the imaging, treatment planning, and dose delivery processes. End-to-end testing of the Perfexion and Gamma Plan version 10.1 has not been previously examined in literature.

Methods: The phantom was imaged using both the CT and T1- and T2-weighted MR sequences used for treatment planning. For imaging, the isocentric volume insert and fiducial markers were positioned within the phantom. Scans were transferred to the Gamma Plan treatment planning system and were evaluated for geometric and fusion accuracy. A plan was created to deliver 12Gy to the 50% isodose line to the 5.25cm³ volume. During dose delivery, Gafchromic EBT2 film was positioned in the film insert to replicate the position of the target volume. Dose results were analyzed using RIT software (Radiologic Imaging Technology, Inc.).

Results: Image fusion integrity was inspected by overlaying the MR and CT markers (5 fiducial markers spaced 5mm apart) and visually examining the resulting volume insert overlap between the three scans. Geometric accuracy was evaluated by contouring three volumes using Gamma Plan contouring tools. Agreement within 1.1%, 6.7% and 12.2% of the actual volumes was seen with the T1-weighted, T2-weighted, and CT images, respectively. The volume-based acquisition and 1mm slice thickness of the T1-weighted sequence resulted in the most accurate measurement. Geometric measurements along two dimensions showed acceptable accuracy for all imaging modalities within 1.6%.

Dosimetry results agreed well with the planned dose. The EBT2 film was calibrated for absolute dose measurements using a dose calibration curve for 0.1-30 Gy and the calibration curve was verified to have <3% error above 1Gy.

Conclusions: The Lucy phantom allows for comprehensive quality assurance testing of the Gamma Knife Perfexion radiosurgery process.