Purpose: The purpose of the study was to develop a procedure using selective region mutual information image registration and anatomic landmarks transformation to improve the treatment accuracy of volume-staged Gamma Knife (GK) radiosurgery for large arteriovenous malformations (AVMs).

Methods: The procedure was implemented via Leksell Gamma Plan (LGP version 9.0) and an in-house point registration program for multiple session staged GK treatments. A requirement of such treatments was to match the partial-volume dose distribution of a previously delivered treatment with the current treatment. In our procedure, MR images of the current treatment plan were first imported and co-registered with the initial reference MR studies via selective region mutual information algorithm in LGP. Then the current MR studies were re-imported and defined for its stereotactic frame. Based on these two MR studies (one registered and one defined), four or more anatomic landmarks surrounding the target region were selected, and then a rigid-body transformation matrix was calculated from these points to map the original treatment plan onto the current treatment plan for the existing frame coordinate system. We analyzed the accuracy of such procedures performed for a group of 12 patients with 14 staged treatments at our institution since 2007.

Results: The average discrepancy in the landmark vector distance between the original treatment plan and the transformed treatment plan was 0.25±0.09 mm. This value was 3-4 times smaller than previously published results. Additional studies on the accuracy of mutual information registration of MR-MR images of the same objects/patients on our LGP system yielded a mean standard deviation of 0.16±0.07 mm, where the largest deviation was generally observed along the image scanning direction.

Conclusions: Volume-staged GK treatments can be delivered to the same level of accuracy as single fraction GK treatments.