AbstractID: 2953 Title: A geometrical method for lesion placement in functional radiosurgery

Purpose: To develop a rigorous mathematical method enabling precise navigation through stereotactic space to functional radiosurgery targets not visualized by any imaging modality.

Methods and Materials: In radiosurgery for functional disorders, Schaltenbrand-Wahren scaling formulas are often used to identify the appropriate target relative to imaged brain anatomies. Stereotactic frame alignment relative to internal brain anatomy is therefore critical, and, consequently, the success of the treatment can be limited by frame misalignments. A mathematical method through which one can define directions in the brain was developed. Such a method enables accurate navigation to appropriate targets based on visible anatomic landmarks regardless of frame positions. The procedure was tested for GammaKnife thalamotomy, where the target is the ventrolateral nucleus of the thalamus. Small simulated targets were placed between three consecutive slices of a head phantom to provide CT-visible anatomy consistent with the Schaltenbrand-Wahren brain atlas. Scaling formulas were then used to navigate from the anterior and posterior commissures to the ventrolateral nucleus, where an additional marker was placed. Other markers were placed along the brain's midplane. A stereotactic headframe was then attached to the phantom four separate times: once with optimal alignment based on external anatomical markings, and 3 times with varying misalignments. The phantom was CT-scanned (1 mm slice thickness) with each frame attachment.

Results: Over all image sets, the average distance between the predicted ventrolateral nucleus and its imaged location was 0.64 mm (maximum of 0.95 mm with greatest frame misalignment), consistent with imaging uncertainty.

Conclusion: It is difficult to align a stereotactic frame to internal anatomy based on external landmarks. A mathematical method independent of frame placement has the potential to improve the accuracy of functional radiosurgery and to lessen the importance of ideal frame placement. Furthermore, this method can be used to confirm lesion placement in functional radiosurgery.