Purpose: In Gamma Knife (GK) radiosurgery, the occurrence of reapplying the stereotactic frame due to collision with the collimator leads to re-examination and re-planning. For the treatment of vascular lesions, it is a burden not only to physicians but also to patients to get invasive angiography procedure again. To avoid undergoing second angiography examination, and reduce re-planning time, a mathematical coordinate transformation method using the stereotactic images has been developed.

Methods: The MR or CT images of a patient brain before and after frame reapplication can be correlated with each other using the Affine transformation. The transformation parameters which minimize the RMS error of the original and transformed coordinates between the images were determined using a genetic algorithm. Three CT image studies of skull phantom were used for the verification of the algorithm. Moreover, five MR image studies of patients who underwent more than one GK procedure were used for the clinical evaluation. The coordinates under the original treatment plan were converted to new coordinates using the transformation matrix, and their dosimetric outcomes were compared.

Results: The RMS error in the coordinate transformation of skull phantom and clinical images was 0.3 mm and 0.6 mm, respectively. For total 9 treatment lesions of 0.2 ~14.1 cc, 3% and 11% RMS error in the irradiation time and target coverage were found respectively. The patients with only translational movement during the frame reapplication showed similar plan conversion results with the original plan. Also, deeply-located lesions showed a better RMS error of 3% in the conformity index than superficial lesions close to the skull.

Conclusions: New treatment plans were obtained by applying the coordinate transformation to the original plans after the frame reapplication. The converted plans maintained the quality of the original plans with a little change in dose distribution arising from head rotation.

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