

Abstract

Purpose/Objective(s): Targeting precision is particularly crucial in Gamma Knife radiosurgery for trigeminal neuralgia. The purpose of this study was to develop a standardized image definition strategy to improve target registration.

Materials/Methods: We conducted a study on 54 patients who underwent Gamma Knife radiosurgery treatment for trigeminal neuralgia. All patients were scanned with two magnetic resonance imaging (MRI) sequences on the day of radiosurgery: contrast-enhanced T1-weighted MRI and three-dimensional fast imaging employing steady-state acquisition (3-D FIESTA) MRI. MRI images were imported into the Elekta Leksell GammaPlan for radiosurgery treatment planning. The trigeminal nerves for all patients were contoured by one experienced neurosurgeon. Image registration of T1-weighted and FIESTA MRI scans was achieved through definition of the fiducial markers. We evaluated four registration methods: automatic image definition, manual definition through superior slices, middle slices, and inferior slices. Target discrepancies were measured by the deviations of an intracranial landmark on T1-weighted and FIESTA MRI images. We verified our results with in-house software using a landmark-based rigid registration algorithm.

Results: For T1-weighted MRI, automatic image definition was achieved in 50 (93%) of 54 patients and no difference was found in the coordinates of the intracranial landmark using T1-weighted automatic or manual definition. For FIESTA MRI, automatic image definition was achieved in 7 patients (13%). The most accurate registration strategy for FIESTA MRI was achieved using middle slice definition with mean error of 0.45 ± 0.41 mm ($p < 0.01$). We confirmed these clinical findings with a landmark-based MRI registration algorithm.

Conclusion: Our study demonstrated that T1-weighted and FIESTA MRI registration through image definition in GammaPlan affected targeting accuracy in Gamma knife radiosurgery for trigeminal neuralgia. We recommend a standardized registration strategy using manual definition of middle slices for T1-weighted and FIESTA MRI to further improve targeting.