

Inhomogeneity effect on Gamma Knife Stereotactic Radiosurgery

Purpose: To study the inhomogeneity effect from skull and air cavity on Gamma Knife Stereotactic Radiosurgery.

Method and Materials: Patient CT data from Gamma Knife procedure was used in a Monte Carlo simulation. In the Monte Carlo simulation, the 201 Cobalt-60 sources were considered to have the same activity. Each Cobalt-60 source was contained in a cylindrical stainless steel capsule. The beam data was stored in four beam phase-space files which were generated in the inner side for each of 4 treatment helmets, after the Cobalt beam passed through primary collimator and secondary collimator. The dose was calculated using Monte Carlo simulation in both homogenous and inhomogeneous geometries rebuilt from patient CT data with identical beam parameters. A small volume was created around the iso-center for DVH comparison. The doses in a 16cm diameter spherical QA phantom were also measured and calculated with and without 1.5mm Lead-covering.

Results: For QA phantom, the dose ratios with and without 1.5mm Lead covering are 89.8% from measurement and 89.2% from Monte Carlo. For patient's CT phantoms, Monte Carlo results show that although the isodose lines remain almost the same with and without inhomogeneity correction, the difference in absolute dose has been observed. The dose in CT phantom is about 4.1% lower than the dose in water replaced CT phantom. With various skull densities, the inhomogeneity effect could reach as high as 8.0%.

Conclusion: Monte Carlo has been applied to dose comparison for CT image with and without inhomogeneity correction. Monte Carlo simulation matches very well with measurement for the spherical QA phantom. It shows that the implementation of Monte Carlo simulation for Gamma Knife is accurate. It shows that the inhomogeneity effect should be considered for gamma knife treatment planning.