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Dosimetric comparison of two models of $^{106}Ru/^{106}Rh$ eye plaque in brachytherapy treatment of eye melanoma using GATE Monte Carlo code

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Abstract

The use of brachytherapy using ophthalmic plaques due to their lower cost, and ease of access compared to other radiotherapy methods is widely used to treat various types of eye malignancies, especially uvea melanoma (iris, ciliary body, and choroid). Beta emitter applicators of $^{106}Ru/^{106}Rh$, have a lot of use in brachytherapy of intraocular tumors. Treating eye melanomas using beta-emitting $^{106}Ru/^{106}Rh$ plaques in Europe and Iran is popular. Estimating the dose distribution of eye plaques according to the location of the tumor is of great importance. In this study, two $^{106}Ru/^{106}Rh$ betta emitter concave eye plaque models, CCA and CCB, manufactured by the BEBIG Eckert & Ziegler BEBIG GmbH Company, were simulated using GATE Monte Carlo simulation code. Knowledge of the exact dose distributions in tumors and each organ at risk is critical in eye plaque brachytherapy for uveal melanoma treatment. In this regard, an eye phantom includes different parts sclera, choroid, retina, cornea, vitreous, optic nerve, lens, cornea, anterior chamber, and a tumor with thickness of 3 mm and a base diameter of 10 mm, were modeled using the GATE Monte Carlo simulation code. For validation purposes, at first, the energy spectrum of the 106Ru/106Rh source used in the study was verified as an isotropic point source centered in a water phantom using beta particles with a maximum energy of 3.54 MeV. Then the plaque central axis depth dose in the eye phantom was calculated using GATE and compared with available data. Furthermore, the difference between the deposited dose in the different components of the eye phantom shows that due to its smaller dimensions, the CCA eye plaque not only causes more concentration of the dose deposition in the tumor tissue but also greatly reduces the dose reaching structures such as the lens, as a sensitive volume.

Keywords: brachytherapy, ophthalmic plaques, eye melanoma, $^{106}Ru/^{106}Rh$ source, GATE Monte Carlo code.

For full article, refer to the Persian section.