Collimator Output Factors for Leksell Gamma Unit Based on the Measurement Using a Diode Detector and Monte Carlo Simulation

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Although 4 mm collimator has been used in the Gamma Knife radiosurgery since 1983, its output factor relative to the 18 mm collimator is still a controvertial issue. Measurement in different Gamma Knife centers yields a result ranging from 0.780 to 0.900.

In this investigation, we design a miniature diode detector which fits exactly into the standard 16-cm diameter polystyrene phantom. The effective volume of the diode detector is about 0.04 mm³, with the maximum linear dimension no bigger than 1 mm. Its ionization response to the radiation for the 14, 8, and 4 mm collimators relative to that for the 18 mm collimator is 0.978, 0.944, and 0.896, respectively. We did a Monte Carlo simulation of the diode detector to obtain the absorbed dose output factors and the electron spectra traversing the silicon diode. The output factors obtained in the computer simulation agrees with the measured ones within 2%.

The same Monte Carlo simulation codes were applied to an imaginged detector made of water and immensed at the center of a 16-cm diameter water phantom. The output factors obtained are 0.978, 0.943, and 0.847 for the 14, 8, and 4 mm collimators, respectively, compared with 0.985, 0.952, and 0.800 suggested by the manufacturer.