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Calculation of Secondary Neutron Dose Equivalent in Proton Therapy of Thyroid Gland Using FLUKA Code

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Abstract : Proton radiotherapy (PRT) is becoming an established treatment modality for cancer. The localized tumors, the same as undifferentiated thyroid tumors are insufficiently handled by conventional radiotherapy, while protons would propose the prospect of increasing the tumor dose without exceeding the tolerance of the surrounding healthy tissues. In spite of relatively high advantages in giving localized radiation dose to the tumor region, in proton therapy, secondary neutron production can have significant contribution on integral dose and lessen advantages of this modality contrast to conventional radiotherapy techniques. Furthermore, neutrons have high quality factor, therefore, even a small physical dose can cause considerable biological effects. Measuring of this neutron dose is a very critical step in prediction of secondary cancer incidence. It has been found that FLUKA Monte Carlo code simulations have been used to evaluate dose due to secondaries in proton therapy. In this study, first, by validating simulated proton beam range in water phantom with CSDA range from NIST for the studied proton energy range (34-54 MeV), a proton therapy in thyroid gland cancer was simulated using FLUKA code. Secondary neutron dose equivalent of some organs and tissues after the target volume caused by 34 and 54 MeV proton interactions were calculated in order to evaluate secondary cancer incidence. A multilayer cylindrical neck phantom considering all the layers of neck tissues and a proton beam impinging normally on the phantom were also simulated. Trachea (accompanied by Larynx) had the greatest dose equivalent (1.24×10-1 and 1.45 pSv per primary 34 and 54 MeV protons, respectively) among the simulated tissues after the target volume in the neck region.

Keywords : FLUKA code, neutron dose equivalent, proton therapy, thyroid gland
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