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Assessment of neutron shielding effect on photoneutron dose reduction produced in high-energy linear accelerator

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Abstract

Introduction and Purpose: Photoneutron production is an important problem during patient radiotherapy with high-energy linear accelerators.In this study, the contribution of some components of accelerator head was investigated. Then it has been tried to decrease the flux and dose equivalent of neutrons with placing the appropriate shield made of borated polyethylene (SBP).

Materials and Methods:MCNPX code was used to simulate the head of 15 MV Siemens PRIMUS linear accelerator. The number of photoneutrons was calculated under the jaws for 15×15 cm^2 irradiation field using F1 tally.The neutron dose equivalent was calculated in the spheres with a radius of7 cm at the distance of 100 cm from target at isocenter and out of irradiation field.

Results: The result indicated that the photoneutron production contribution of components such as primary collimator, flattening filter, jaws, and lead shielding was 66%,2%,29%, and 3%, respectively. Different thicknesses ofSBP decrease the number of photoneutrons crossing the surface located at the bottom of jaws about 67%, 78%, and 81%, for thickness of 1cm, 3cm, and 5cm,respectively. In addition, the neutron dose equivalent at isocenter reduced 17%, 19.7%, and 20%,respectively. The amount of reduction for out of irradiation field were 23%, 30%, and 30%, separately.

Conclusion: According to the obtained result, the primary collimator had the major role in thephotoneutron production.The amount of neutron dose equivalent reduction wasapproximately similarusingSBP with 3cm and 5cm thicknesses. It can be concluded that the shield made of borated polyethylene of 3 cm thickness is an appropriate choice and can decrease the photoneutron dose received by patient.Then itcan be applied forneutron protection during radiotherapy with high-energy linear accelerators.

Keywords: High-energy linear accelerator, Photoneutron dose, neutron shield, Monte Carlo