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Assessment of the absorbed dose uncertainty of prostate due to tissue swelling and radioactive sources displacement in brachytherapy using Monte Carlo method

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Abstract

Brachytherapy is a kind of cancer treatment in which radiation sources are implanted inside or close to the cancerous tissue. The purpose of this research is to calculate the absorbed dose uncertainty of prostate tissue, due to its swelling, displacement of the implanted seed sources and also, to address the effect of these factors simultaneously, in brachytherapy of prostate. In this research, MCNPX2.6 code, the TG-43U1 protocol and ORNL body phantom were used to simulate the brachytherapy of prostate using iodine-125 seed sources. In the first study, 84 sources of iodine with the shapes of seed and then points were implanted inside the prostate with the volume of 38.01 cm^3. The radiation absorbed dose was found to be 110.59 and 110.57 Gy, respectively. Considering the 50% prostate inflation after implantation, the radiation absorbed doses of prostate showed a reduction of more than of 17%. In the second therapeutic plan, by using 76 seed sources of I-125, considering 12% swelling of prostate and applying the displacement of seed sources in three directions: left–right (1.8mm), front-back (2.1mm) and top–down (3.4mm)), the radiation dose amount of the cancerous tissue was reduced about 21%. So, the results of seed and point sources of brachytherapy were very close to each other. Therefore, in simulation studies, point sources can be used instead of seed sources to reduce the computational complexity. Also, this research showed the effects of swelling and displacement of brachytherapy sources on the amount of the absorbed dose of prostate and its treatment were noteworthy.

Keywords: prostate cancer, brachytherapy, absorbed dose uncertainty, Monte Carlo method

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