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Out-of-field doses in radiotherapy treatments of paediatric patients

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Out-of-field doses are delivery to healthy tissues, which may allow the development of second tumours. Its evaluation with MC methods is essential since these doses are inaccurate when calculated by TPSs. The use of IMRT has been discussed, especially in paediatric patients, as it leads to a "bath" of low doses to large volumes of out-of-field tissue.
This study aims to evaluate out-of-field doses in paediatric tumours by comparing 3DCRT and IMRT techniques. Thus, a computer model of a LINAC, as well as its 6 MV energy photon beam, and MLC, were initially modelled and validated in MCNP6. Subsequently, CT images of a paediatric anthropomorphic phantom were acquired in IPOLFG and with the ImageJ program; a voxelized paediatric computational phantom was created. Two dosimetric plans were performed, one with the 3DCRT technique and the other with the IMRT technique. Experimental measurements were carried out in LINAC with the paediatric anthropomorphic phantom and with TLDs reproducing the treatment plans previously created in TPS.
In the MCNP6 program, the model of the LINAC was added in an unprecedented way, with its MLC and the 6 MV energy photon beam, as well as the previously created voxelized phantom and the out-of-field doses for all organs were calculated for both techniques.
The results have shown that out-of-field doses can be seriously underestimated with TPSs. The out-of-field doses are higher when using the IMRT technique (right eye = 13040.6 mGy), compared to the 3DCRT technique (right eye = 593 mGy).
This study demonstrates a powerful combination of (1) dosimetric measurements in a clinical environment, (2) modelling of a LINAC, treatment beam and MLC, (3) out-of-field organ doses in a paediatric phantom, (4) creation of a voxelized paediatric phantom. This could have an impact in radiological protection and dosimetry in radiotherapy services.

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