Radiation doses to normal tissues and organs outside the target volume during radiotherapy

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Public Health Codes more and more require that any information relevant to the estimation of the high doses delivered within the target volumes and low doses delivered outside should be recorded. In this context, the availability for each radiotherapy patient of the magnitude of the unavoidable low doses delivered outside the target-volumes becomes an important issue. However, to date, Treatment Planning Systems (TPS) are not designed for this issue. Therefore, we have developed a new version of the ISOgray TPS which can provide, in addition to the doses distributions in the fields, the magnitude of the doses to distant healthy tissues in the course of common radiotherapeutic procedures. Our strategy involves 3 modules: A library of adjustable whole-body patient models in treatment position which allows different patient anatomies to be simulated; A multi-sources beam model, which allows the description of the irradiation field to be extended to the whole body; A dose calculation engine producing the distributions of doses in the fields and in any organ outside. This paper describes the principles of the system and provides data on doses distributions to distant organs for various common radiotherapeutic procedures. At this stage of development, the agreement of measured and calculated doses reaches ±3% in the radiation field and is better than ±15% outside. In the case of a 17 years aged girl treated for Hodgkin's disease using two 6MV opposite photon beams, when a dose of 20 Gy was delivered to the target volume, outside the beam, the dose to the brain was 0.37 Gy (1.85% of the tumor dose), the kidney 0.06 Gy (0.30%) and the ovaries below 0.02 Gy (<0.1%). Although the development of our system is still in progress, these preliminary results are encouraging. Allowing the realization of whole-body dose evaluations for each patient in the course of radiation therapy treatment planning, our approach must provide relevant information required to meet the current requirements of patient radiation protection and radiation therapy benefit-risk management purposes. The systematic evaluation of low doses outside the radiation therapy fields creates new opportunities in quality assurance of radiation therapy and prospective studies of long-term risks of radiation modern radiotherapeutic procedures.

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