A Monte-Carlo tool to compute peripheral doses for breast radiotherapy : preliminary study

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Introduction

With cancers diagnosed earlier and treatments becoming more efficient, patients are surviving longer with an increased probability to develop a secondary cancer. It is well known that some of these secondary cancers are attributed to radiation for patients who underwent radiotherapy. However the relationship between the dose and the risk is less known and there is great uncertainty about the shape of the dose-risk curve at high doses[1]. Studies suggest that most cancers arise outside the fields in regions receiving lower doses than the target volume[2]. Peripheral dosimetry is usually not available and treatment planning systems cannot compute accurate doses outside the irradiation fields. The aim of this study is to develop a Monte-Carlo based tool, which enables to calculate out-of-beam doses to organs as a function of the morphology of the patient and the irradiation parameters. The tool is restricted to patients treated for breast cancers since it is the most common cancer among women and its cure rate is high. Therefore many patients treated for breast cancers survive for a long time with an increasing probability to develop a second malignancy related to the radiation treatment.

Material and methods

109 files of patients treated between 1978 and 2000 for breast cancer with radiation and having developed a secondary cancer were extracted. Morphological parameters such as weight, height and dimensions of the breast and technical parameters such as type of machine, type of field, energy of the beam, sizes of the field and angle of the gantry were extracted for each patient. The variability of each parameter was analyzed in order to identify the parameters that could be eliminated or fixed at a certain value and those that are kept as variables affecting peripheral doses.

Results

The analyses of the parameters show that height, weight, dimensions of the breast, gantry angle of the tangential fields and dimensions of the fields vary considerably. Most parameters can be reasonably well fitted with a lognormal or a Gaussian distribution. By modeling five types of fields (two tangential fields, one sternal field, one AP field and one PA field), we can reconstruct the doses for 85% of the cases. All the photon treatments were either delivered by a cobalt-60 unit or a LINAC 6 MV. Electrons will be neglected since they do not contribute to the peripheral dose. The impact of each parameter on the peripheral dose will be investigated.

Discussion

The Monte-Carlo based tool will enable to compute dose distributions to organs outside the beams as a function of the morphology of the patient and the irradiation parameters. It will be possible to take into account inhomogeneous dose distributions across organs. As it has been shown by Dasu et al.[3], this approach is necessary to better ascertain the relationship between the risk and the dose

References

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