Use of the BEAM Monte Carlo Code to calculate surface doses for breast radiotherapy

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ABSTRACT

Introduction: Many women with breast cancer will be treated with radiotherapy. For the majority of these patients, the skin is not part of the clinical target volume, however it is often irradiated to a high dose because of the use of tangential beams, which leads to erythema (reddening of the skin). For other women, where there may be spread of tumour to the skin, it is included in the target volume. For these women, additional material may be added to the patients skin (bolus) to increase the surfaces dose. As the angle of incidence of the radiation beam increases, the surface dose will increase and the depth of dose maximum will decrease. Traditional planning systems are often unable to calculate the dose to the skin due to limitations in their algorithms and inaccuracies in the data for the surface dose.

Methods: Measurements of surface dose both for flat phantoms and curved surfaces were performed on an Elekta SL15 linear accelerator at 6MV using film, extrapolation chamber and Markus chamber at a variety of gantry angles and for a range of field sizes from 5x5cm^2 to 9x20cm^2. The accelerator was modelled using the BEAM Monte Carlo code. Electron (ECUT) and photon (PCUT) transport cut-off energies of 0.521MeV and 0.01MeV respectively were used. No range rejection or Bremsstrahlung splitting was used. Phantoms simulated using DOSXYZ.

Results: Surface doses calculated using Monte Carlo agreed well with those measured using a Markus chamber (corrected for over-response using the Rawlinson correction). The Monte Carlo results at a depth of 0.025mm gave values of between 14.8% of Dmax for a 5x5cm^2 field to 22.3% of Dmax for a 9x20cm^2 field at normal incidence. These values increased to 53% for a 9x20cm^2 field at a gantry angle of 75°. As the gantry angle is increased there is a corresponding decrease in the perpendicular depth of Dmax and the magnitude of the dose at Dmax.

A major component of the skin dose in breast radiotherapy is the exit dose. Decrease in dose at a beam exits the patient has also been investigated and differences of between 11 and 44% for a 10 x10 cm^2 field were observed in the last 0.05mm as the gantry angle was increased from zero to 75°.

Conclusion: Results calculated with Monte Carlo agree well with those measured on a linear accelerator. The use of Monte Carlo allows accurate calculation of surface doses for breast radiotherapy.