Effect of small photon field on dose distribution in transverse magnetic field: A Monte Carlo study

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Research

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Abstract

Background: To investigate the effect of small photon field on dose distribution in transverse magnetic field by simulating the dose distribution on homogenous and heterogenous phantoms.

Methods: EGSnrc simulation was used to calculate the dose distribution of four phantoms irradiated by small photon field in transverse magnetic field $B=0T$, $B=0.35T$ and $B=1.5T$. The photon beams were based on the phase space file of Varian Clinac_iX 6MV from the IAEA's online accelerator phase space database. The size of beams was $0.5cm \times 0.5cm$, $1cm \times 1cm$, $2cm \times 2cm$ and $4cm \times 4cm$, respectively.

Results: In homogenous water phantom and 1.5T magnetic field, the distance of the dose build-up region decreased by 4mm compared with that without magnetic field. At the edge of the water phantom, the dose of central axis changed a 1.7% decrease in the field of $0.5cm \times 0.5cm$ to a 27% increase in the field of $4cm \times 4cm$. The lateral profiles shifted by 1-3mm and the dose penumbra had asymmetry. In 0.35T magnetic field, the effect of magnetic field was insignificant.

In water-air and water-lung phantom, the dose at the water-air and water-lung interface increased by 24.2%, 30.9%, respectively. However, at the air-water and lung-water interface, it decreased by 10.9% and 29.9% in the field of $2cm \times 2cm$. In 0.35 T magnetic field, there was no significant change in the dose at the interface. In water-bone phantom, the dose at the water-bone interface increased.

Conclusions: In 1.5T magnetic field, when the field was small, the shift of lateral profile was obvious and the dose penumbra had asymmetry. At the interface of different tissue, the dose change depends on the size of the field, the strength of magnetic field and the change of tissue density. The effect of the magnetic field on the dose distribution needs to be considered during optimizing a treatment plan, to avoid dose hotspots at normal tissues.

Full Text

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Figures

Figure 1

The PDD curves of water phantom in different size of beam field with magnetic field compared with those without magnetic field. (a) $B = 0.35\text{T}$. (b) $B = 1.5\text{T}$

Figure 2

The dose profiles of water phantom in different size of beam field with magnetic field $B=0.35\text{T}$ compared with those without magnetic field at the depth of the maximum dose. (a) Dose profiles in the X direction. (b) Dose profiles in the Y direction

Figure 3

The dose profiles of water phantom in different size of beam field with magnetic field $B=1.5\text{T}$ compared with those without magnetic field at the depth of the maximum dose. (a) Dose profiles in the X direction. (b) Dose profiles in the Y direction

Figure 4

The PDD curves of water-air phantom in different size of beam field with magnetic field compared with those without magnetic field. (a) $B = 0.35\text{T}$. (b) $B = 1.5\text{T}$

Figure 5

The PDD curves of water-lung phantom in different size of beam field with magnetic field compared with those without magnetic field. (a) $B = 0.35\text{T}$. (b) $B = 1.5\text{T}$

Figure 6

The PDD curves of water-bone phantom in different size of beam field with magnetic field compared with those without magnetic field. (a) $B = 0.35\text{T}$. (b) $B = 1.5\text{T}$