In vivo dosimetry with surface diodes during total body irradiation: a patient thickness factor to correct midline dose

Total body irradiation (TBI) is used to suppress patient immune response prior to bone marrow transplant for hematopoietic diseases. One way to deliver a uniform total body dose is via photon treatment at extended distance. At our institution, physicians prescribe a dose to patient midline and a uniformity requirement of 5-10% in the rest of the body. Patients are set up in a TBI frame and rotated for AP and PA delivery. The TBI beam is characterized by a custom flattening filter tray accessory and a standing polycarbonate beam spoiler in front of the patient. Polycarbonate compensators of variable thickness are mounted at various heights to increase dose uniformity within the patient. In vivo dosimetry (IVD) is used at the time of treatment to verify patient dose.

One method to verify dose at patient midline is to average entrance and exit surface diode measurements, which has the advantage of approximating patient composition into the IVD. While this method requires an inverse square law correction for both diodes and a TPR correction for the exit diode, commissioning measurements of the extended distance TBI beam showed a linear relationship over the range of 10-20 cm typical for most patients (Fig 1), with deviations below the typical diode uncertainty expected from incident beam angle, temperature, and energy spectrum. However, a retrospective analysis of recent TBI for patients with very large midsection thicknesses, and patients treated in lateral profile on a gurney due to illness, revealed correlation between patient thickness and lower-than-expected diode readings.

Consequently, we designed phantom studies to examine the impact of patient thickness on surface IVD measurements under TBI conditions. We found that surface diodes overestimated midline dose relative to a farmer chamber at midline as a linear function of thickness, up to 6.8% at 40 cm thickness (Fig 2). The resulting development of a patient thickness correction factor for diode IVD will prevent misguided clinical intervention to monitor units or compensation for patients with measurements greater than 30 cm.

Innovation/Impact: This technique will improve accuracy of in vivo dosimetry with surface diodes for patients receiving TBI, allowing for more uniform dose delivery to the patient.

Fig. 1: TPR values for TBI setup at commissioning. Measurements suggested linear TPR for the extended TBI beam over the range of 10-20 cm patient thickness.

![TPR values for TBI setup at commissioning](image)

Fig. 2: Surface diode measurement normalized to midline farmer chamber measurement at extended patient thickness. Diode overestimation relative to farmer chamber measurement increased linearly up to 6.8% at 40 cm.

![Surface diode measurement normalized to midline farmer chamber measurement](image)