Purpose: We have been developing a fast-neutron spectroscopic technique to quantitatively image the distribution of elements in the body using quasi-monochromatic neutron beams. Previously, we demonstrated the ability of the technique to quantify specific elements in the liver and breast while limiting radiation dose to clinically acceptable levels. Here we present the results of a physical dose measurement performed through neutron irradiation of 3D PRESAGE dosimetry phantoms.

Methods: Two PRESAGE optical-CT dosimeters were placed inside a physical phantom of the human torso and irradiated with 8 MeV neutrons produced via the 2H(d,n) reaction using a tandem Van-de-Graaff accelerator. The dosimeters, measuring 10 cm and 4 cm in diameter, were located in regions corresponding to the liver (10 cm), and the kidney (4 cm). Irradiation was performed with the neutron beam incident directly on the larger dosimeter. Cumulative neutron fluence incident upon each dosimeter was determined using an aluminum-foil activation technique. Following irradiation, the change in optical density in both dosimeters was measured to determine the relative irradiation and dose distribution in each volume.

Results: Both PRESAGE dosimeters exhibited detectable changes in optical density corresponding to the dose deposited in the volume. The two dosimeters registered doses of 8.5 Gy (direct incidence, 4.5 hour irradiation) and 0.25 Gy (off-axis, 20 hour irradiation), respectively. The larger dosimeter showed highest intensity at the entry point of the beam with exponential drop-off along the beam direction. The smaller dosimeter registered a more uniform change in intensity, consistent with the higher incidence of scattered neutrons at this location.

Conclusion: The results demonstrate the utility of PRESAGE dosimeters in measuring dose from neutron irradiation and highlight the difference in relative doses between primary and proximal organs when exposed to neutron beams.

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