In Vivo Dose Measurements for Total Body Irradiation using Optically Stimulated Luminescent Dosimeters

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Purpose

To evaluate optically stimulated luminescent dosimeters for *in vivo* dosimetry of patients undergoing Total Body Irradiation.

Materials and Methods

The institution's standard of care for total body irradiation uses a 6 MV Varian 600C linac with the gantry angle at 90 degrees and field size of 40x40 cm². The patient's midline is at 350 cm SMD. A 1.2 cm acrylic spoiler is place 40 cm from the surface of the patient and an acrylic tray holding lead compensators is at the head of the gantry. Solid water phantom measurements were made to determine feasibility of optically stimulated luminescence dosimeters (OSLDs) for *in vivo* dosimetry of patients undergoing total body irradiation (TBI). A 30x30x21 cm³ solid water phantom was placed at 350 cm SAD. OSLDs, TLDs and a calibrated plane parallel ROOS ion chamber were placed at the center of the phantom under 1 cm of build up. Figure 1 shows the position of the dosimeters on the solid water phantom. 100 cGy was delivered to the midplane (10.5 cm depth) of the phantom for single AP field.

Field 1. ROOS chamber, TLDs and OSLDs on the solid water phantom for TBI dosimetry

A similar setup using an anthropomorphic phantom at 350 SAD was used to compare TLD and OSLD measurements at three different locations (Figure 1.) Bolus with 1 cm thickness covered each pair of dosimeters. Solid water measurements did not include the use of lead compensators. Surface dose measurements were made.

Ion chamber measurements were recorded at the time of treatment. OSLDs and TLDs were read one hour after irradiation. TLDs were read using a VICTOREEN 2800 M Thermoluminescence Dosimeter Reader. A calibration factor was applied to determine surface dose measurement on the solid water phantom and the Rando phantom. OSLDs were read using the InLightTM Systems' microStar and the results were exported to an excel spreadsheet. Measurement values were given in cGy with out the need of calibration as needed with TLDs.

In addition, *in vivo* measurements were made for seven patients undergoing total body irradiation at nine different body locations. Again, OSLDs and TLDs were read an hour after irradiation and recorded.

Results

During the annual TBI calibration, OSLD phantom measurements were in agreement of the ROOS chamber (2.4%) and TLDs (4.8%) when using the solid water phantom. See Table 1. Comparative measurements between TLDs and OSLDs differed by as much as 7.6% for the anthropomorphic phantom irradiation that followed the institution's standard of care for total body irradiation. *In vivo* dosimetry using OSLDs for the three patients agreed within (7.6%) for TLDs. *In vivo* measurements are shown in Table 2.

Dosimeter	Surface dose measurement	% difference from ROOS
ROOS	135.5	-
OSLD	138.9	2.4%
TLD	132.6	-2.2%

Table 1. Comparison of OSLDs, TLDs, a ROOS Plane Parallel Ion Chamber used for surface dose measurements following this institution's standard of care for total body irradiation.

Site	Average TLD Midplane Dose	Average OSLD Midplane Dose	Percent Difference
Head	107.9	101.60	-6.2%
Neck	106.6	105.17	-1.4%
Shoulder	99.9	98.55	-1.3%
Mediastinum	102.3	97.67	-4.7%
Umbilicus	93.2	91.22	-2.2%
Hip	95.8	91.17	-5.1%
Thigh	101.9	94.70	-7.6%
Knee	101.3	101.50	0.2%
Ankle	101.8	100.55	-1.3%

Table 2. Comparison of OSLDs and TLDs used for *in vivo* measurements of three patient's undergoing total body irradiation

Conclusions

Results for both the phantom and patient measurements confirm that OSLDs are both suitable and recommended for required *in vivo* dosimetry in Total Body Irradiation. The easy handling of the OSLDs, the ability to quickly read and export the data results to an excel spreadsheet are advantages of the use of TLDs that have been used in the past for TBI measurements.

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