Characterization of Optically Stimulated Luminescence detectors for organ dose phantom measurement in diagnostic radiology

Innovation/Impact: The purpose of this study was to develop a practical method for estimating organ doses from diagnostic x-ray exams that can be performed with readily available phantoms and dosimeters. The feasibility and accuracy of using aluminum oxide doped with carbon (Al_2O_3:C) and beryllium oxide (BeO) optically stimulated luminescence (OSL) detectors were investigated and compared with the TLD results. Our results suggests that BeO and Al_2O_3:C OSL detectors are capable of being used for in-phantom measurement of dose in diagnostic radiology. The flexibility of OSL allows for more control over readout and reuse of the detectors when compared to TLDs, giving this technique promise for estimating patients' organ doses and the effective dose in diagnostic x-ray exams.

Materials and Methods: The energy response of each type of detector as a function of in-phantom depth was determined using PMMA phantom and an ionization chamber (0.4 cm^3) for varying tube voltages of 80 and 120 kVp. Percent depth doses and calibration factors were derived as the ratio of detector signal and the ionization chamber reference condition.

Results: The percent depth dose for the three detectors and the ionization chamber are shown in Table 1 for 80 kVp. A plot of the calibration factor as a function of depth for the OSL detectors is shown in Figure 1 for 80 and 120 kVp.

Table 1: Percent depth dose and uncertainty for BeO, Al_2O_3:C , TLD-100 and the 0.4 cm^3 ionization chamber normalized to the initial measurement in blocks of PMMA at 80 kVp.

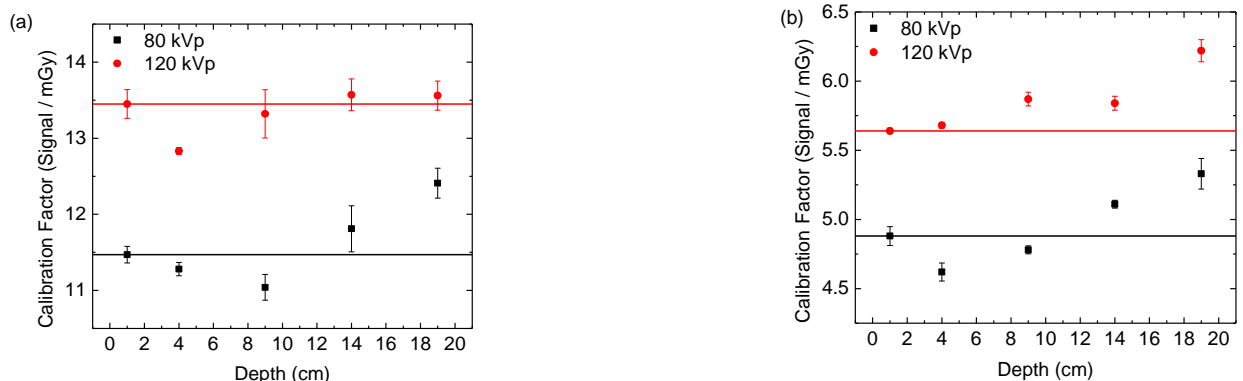| Depth (cm)	BeO			Al_2O_3:C			TLD-100			Ion Chamber		
1	1	±	0.01	1	±	0.014	1	±	0.04	1	±	0.001
4	0.67	±	0.06	0.70	±	0.01	0.72	±	0.02	0.663	±	0.0004
9	0.30	±	0.06	0.295	±	0.002	0.303	±	0.002	0.289	±	0.0002
14	0.076	±	0.002	0.0752	±	0.0004	0.078	±	0.003	0.079	±	0.0002
19	0.024	±	0.003	0.024	±	0.001	0.0253	±	0.0004	0.03	±	0.0002

Figure 1: Calibration factor of (a) BeO and (b) Al_2O_3:C at different depths of PMMA for varying tube voltage.