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Assessment of Dosimetric Perturbations in Small Electron Fields Caused By Optically Stimulated Luminescent Dosimeter for In-Vivo Dosimetry

Ryan Brunkhorst, MS; Yu Lei, PhD; Andrew Joseph Fanning, MS; Tianzhe Li, PhD; Bridget Ann Melke, MS
University of Nebraska Medical Center

ABSTRACT

Purpose: To quantify the dosimetric perturbation introduced by the RadPro **myOSLchip** during in-vivo electron dosimetry in clinically relevant small electron fields used for hypofractionated treatments such as Boom-Boom radiotherapy.

Methods: Measurements were performed in a solid water phantom using a PTW-31010 (0.125 cc) ionization chamber at **dmax** and **d90** for 6 and 9 MeV electron beams. Circular cutouts (2, 3, 4, and 5 cm) and a 10×10 cm² field were evaluated. Relative dose differences were determined by comparing measurements acquired with and without a myOSLchip positioned upstream of the chamber.

Results: The myOSLchip reduced measured dose for all field sizes, with larger perturbations observed at 6 MeV. The greatest reductions occurred for the 2 cm cutout, reaching **10.4% (dmax)** and **11.7% (d90)** at 6 MeV. For 9 MeV, maximum reductions were approximately **9%**, while larger field sizes showed dose decreases of **5–7%**.

Conclusion: The myOSLchip introduces measurable dose perturbations in small electron fields, particularly at lower energies. These effects should be considered when implementing and interpreting in-vivo electron dosimetry to ensure accurate clinical dose verification.

CONTACT

Ryan Brunkhorst
University of Nebraska Medical Center
505 S 45th Street, Omaha, NE, 68106
rbrunkkhorst@unmc.edu
402-250-3291

INTRODUCTION

In-vivo dosimetry in electron radiotherapy ensures accurate plan delivery and patient safety. In hypofractionated treatments such as Boom-Boom radiation (2 Gy in 2 fractions) for indolent B-cell non-Hodgkin lymphomas, the use of small cutout fields increased dose calculation and setup uncertainties, making in-vivo dosimetry valuable. RadPro International GmbH's myOSLchip offers a practical in-vivo dosimetry solution for its small size and usability. However, the presence of a dosimeter within small electron fields may perturb the delivered dose. This study quantifies the magnitude of dosimetric perturbation introduced by the myOSLchip in clinically relevant small electron fields.

METHODS AND MATERIALS

Measurements were performed in a solid water phantom using an ionization chamber (PTW-31010, 0.125cc) at the nominal depth of maximum dose (dmax) and 90% isodose (d90) depth for 6 MeV and 9 MeV electron beams from a Varian TrueBeam linac. Circular electron cutouts with diameters of 2, 3, 4, and 5 cm were evaluated, along with a 10x10cm2 electron field. For each field size, measurements were acquired under identical conditions with and without a myOSLchip positioned upstream of the measurement location. Relative dose differences were calculated to isolate the dosimeter perturbation caused by the dosimeter.

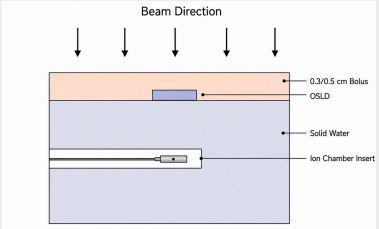


Figure 1. Experimental setup for dose perturbation measurements. The OSLD was placed at the bolus–solid water interface with the ion chamber downstream within the solid water. Diagram not to scale.

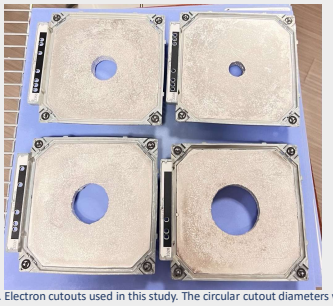
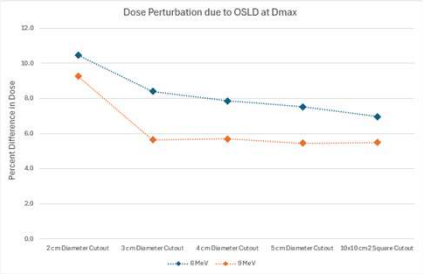


Figure 2. Electron cutouts used in this study. The circular cutout diameters were 3 cm (top left), 2 cm (top right), 4 cm (bottom left), and 5 cm (bottom right). Measurements were also performed using the standard 10 × 10 cm² applicator field (not shown).

RESULTS

Dose perturbations were observed for all field sizes, with larger effects at 6 MeV compared to 9 MeV beams. At 6 MeV and the smallest cutout (2cm), dose reductions of 10.4% at dmax and 11.7% at d90 were observed. In the 10x10cm2 field, myOSLchip caused an approximate 7% dose decrease at both depths. For 9 MeV, perturbations were smaller, with a 9% dose reduction at both depths for 2cm cutout and 5-6% reductions for larger cutouts.



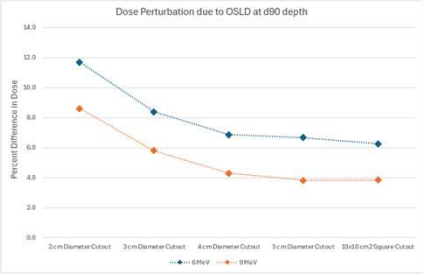


Figure 3. Dose perturbation introduced by the OSLD for 6 MeV and 9 MeV electron beams measured at (A) dmax and (B) d90 as a function of cutout size. Percent dose difference is reported relative to measurements obtained without the OSLD.

	Measurement depth (cm)		10x10 cm² cutout	ϕ2cm cutout	ϕ3cm cutout	ϕ4cm cutout	ϕ5cm cutout
6 MeV	d_{max}=1.3	OSLD/no OSLD	0.930	0.895	0.916	0.921	0.925
	d_{90}=1.7	OSLD/no OSLD	0.937	0.883	0.916	0.931	0.933
9 MeV	d_{max}=2.1	OSLD/no OSLD	0.945	0.907	0.944	0.943	0.945
	d_{90}=2.7	OSLD/no OSLD	0.962	0.914	0.942	0.957	0.962

Table 1. OSLD-to-no OSLD dose ratios measured at d_{max} and d₉₀ for 6 MeV and 9 MeV electron beams across all field sizes.

DISCUSSION

These findings highlight the importance of intelligent application of in-vivo dosimetry. For short fraction treatments utilizing a small-field, a significant dose perturbation caused by a dosimeter has the potential to drastically change the dose received by a target or organ at risk. Appropriate detector selection, positioning, and interpretation of measurements can maximize the clinical benefits of in-vivo dosimetry while minimizing unintended dosimetric effects.

CONCLUSIONS

This work establishes the dosimetric impact of OSL detector placement in small electron fields and supports the informed clinical use of in-vivo dosimetry for hypofractionated electron treatments where delivery accuracy is critical.

REFERENCES

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University of Nebraska Medical Center