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Characterization of Detector-Specific Correction Factors for Optically Stimulated Luminescence Dosimeter-Based Surface Dosimetry

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ABSTRACT

Purpose: While optically stimulated luminescence dosimeters (OSLD) offer advantages in reusability and efficiency, they overestimate the surface dose due to thick effective point of measurement. The aim of this study is to investigate the detector-specific correction factor for two commercial OSLDs to correct surface dose overestimation in breast radiotherapy plans.

Methods: This study was conducted using two OSLD systems, MyOSLchip (RadPro International GmbH, Germany) and nanoDot (Landauer, USA), and Gafchromic EBT4 film (Ashland, USA) was used as reference for surface dose measurement. Surface dosimetry was performed on a female anthropomorphic phantom with left breast attachment. 3D-conformal radiotherapy (3DCRT), Field-in-Field technique (FiF) with tangential fields, intensity-modulated radiotherapy (IMRT), and volumetric modulated arc therapy (VMAT) plans were generated for whole breast with a prescription dose of 2 Gy per fraction. OSLD and film measurements were performed at six positions on the phantom surface and repeated three times per treatment technique. The detector-specific correction factor was derived individually for MyOSLchip (CFmyosl) and for nanoDot (CFnano), using linear least-squares fitting of film responses against OSLD responses at same measurement positions. The relative dose difference between film and OSLD were calculated before and after applying CF to OSLD readings.

Results: The relative dose difference between EBT4 film and OSLD measurement indicates that OSLD overestimate surface dose by 17.70% - 46.71% for myOSLchip and by 7.69% - 21.48% for nanoDot, depending on measurement position and treatment technique. CFmyosl and CFnano values for correcting OSLD measurement to film response were calculated as 0.73 and 0.88, respectively. After applying CFmyosl and CFnano for OSLD measurements, the relative dose difference between EBT4 film and corrected OSLDs was reduced, ranging from -8.88% to 14.98% for myOSLchip and from -11.28% to 9.07% for nanoDot.

Conclusion: Detector-specific correction factors proposed in this study were effective to mitigate OSLD overestimation of surface dose in breast radiotherapy plans. The proposed CFlmyos and CFnano may be easily applied in clinics. Additional correction methods incorporating beam incidence angle, field size, and other factors affecting the detector response are needed to further reduce the dose difference ratio between surface dose and corrected OSLD.

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INTRODUCTION

- OSLD offers flexible use in patient dosimetry through signal stability, fast readout and reusability [1].
- OSLD may overestimate surface dose compared with other dosimeters due to its inherent buildup [2].
- This study aimed to derive correction factors to compensate for OSLD overestimation of surface dose

METHODS AND MATERIALS

Measurements

- Four radiotherapy (RT) plans for the left breast of a female anthropomorphic phantom
- Prescription dose 50 Gy, 2 Gy per fraction

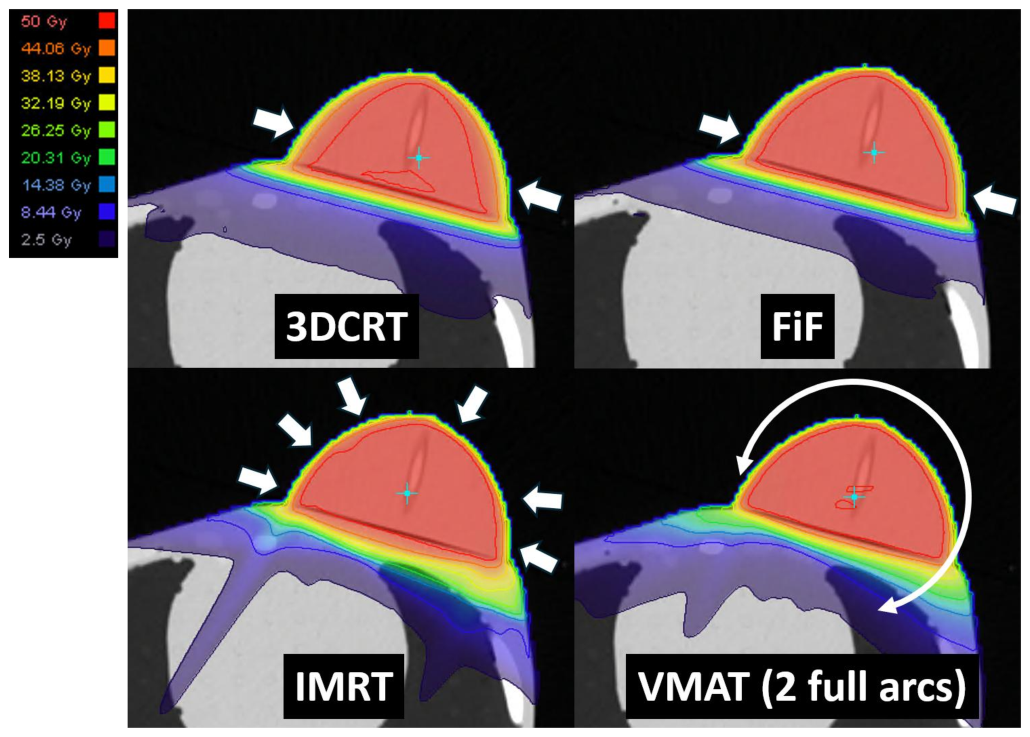

Figure 1. Treatment plans using 3D conformal radiotherapy (3DCRT), field-in-field (FiF), intensity-modulated RT (IMRT), and volumetric-modulated arc therapy (VMAT). White arrows indicate beam delivery angle.

- Surface dosimetry using film (baseline) and OSLD systems
  - EBT4 film (Ashland, USA)
  - MyOSLchip (RadPro International, Germany)
  - nanoDot (Landauer, USA)

- Measurement positions included 5 on target breast surface, 1 on midpoint of breasts (out-of-field)
- Measurements were repeated 3 times on separate days

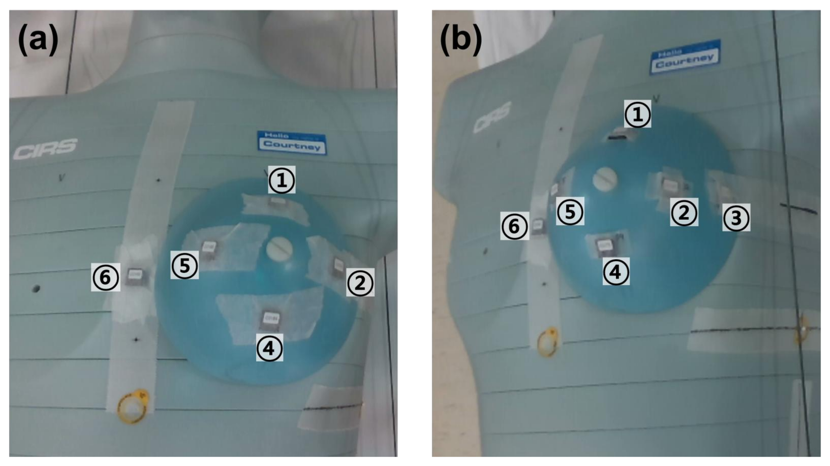

Figure 2. Six measurement points on the phantom surface

Correction factor (CF)

- CF values for MyOSLchip (CF_{myosl}) and nanoDot (CF_{nano}) were derived by linear least squares fitting to EBT4 film measurements

Evaluation metric

- Relative dose difference (%) = (OSLD-Film)/Film * 100

RESULTS

Comparison of OSLDs and film in surface dosimetry

- Under all measurement conditions, OSLDs overestimated surface dose compared with film
- Relative dose differences varied by treatment technique and measurement position
  - myOSLchip: 17.70% to 46.71% (14.26 cGy – 54.91 cGy)
  - nanoDot: 7.69% to 21.48% (6.16 cGy – 25.06 cGy)

OSLD correction factor application

- CF_{myosl} = **0.73**, CF_{nano} = **0.88**
- Relative dose differences were reduced after applying CF_{myosl} and CF_{nano}
  - myOSLchip: -14.98% to 8.88% (-13.15 cGy – 9.17 cGy)
  - nanoDot: -9.07% to 11.28% (-9.77 cGy – 11.65 cGy)

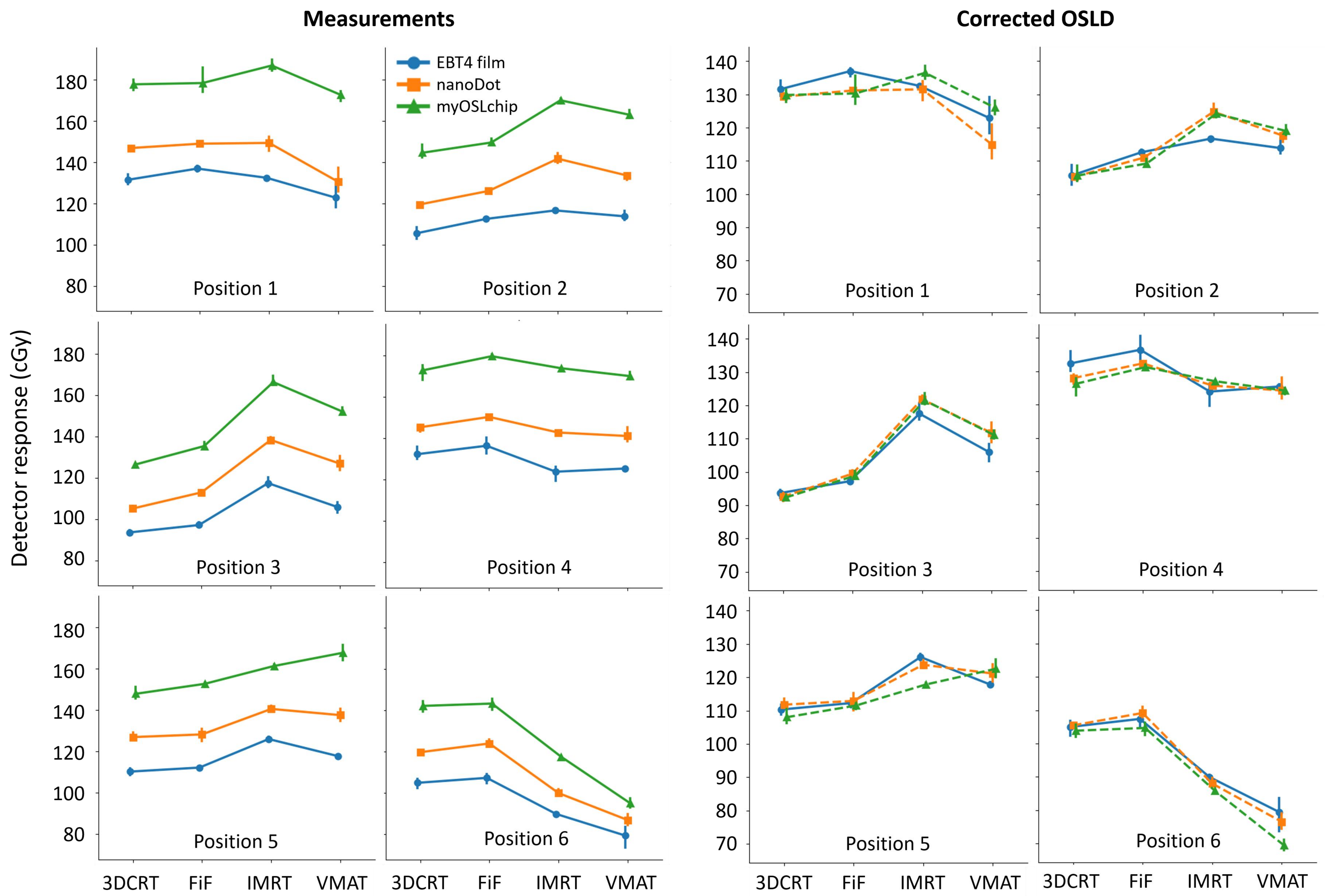

Figure 3. Comparison of OSLDs and film measurements in surface dosimetry. Dose differences observed in original measurements (left) were reduced after applying OSLD correction factors, CF_{myosl} = 0.73 and CF_{nano} = 0.88 (right).

DISCUSSION

- Notable dose differences were observed between OSLD and film measurements in surface dosimetry
- The mean dose difference between film and corrected OSLDs across all measurement conditions was <5% (3.69% ± 3.13% for myOSLchip, 2.91% ± 2.45% for nanoDot)
- Even after applying CF, dose differences relative to film could exceed 10% depending on measurement position and planning technique.

CONCLUSIONS

- Correction factors are required to estimate superficial dose from OSLD-based surface dosimetry
- The proposed CF_{myosl} and CF_{nano} may simplify surface dose estimation with OSLDs, and further studies are needed to ensure robust correction across different plans and measurement positions.

REFERENCES

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