Experimental Determination of in-water Relative Dose Distribution for a Novel Y-90 Disc Source with 3D-printed Film Dosimetry Tools

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PURPOSE / OBJECTIVES
To characterize the in-water percent depth dose (PDD) curve and dose profiles of the novel Y-90 planar source (Liberty Vision, Portsmouth, NH)¹ for treating ocular melanoma using Gafchromic EBT3 films and 3D-printed film holders.

MATERIAL & METHODS
A low-cost desktop 3D printer (Ender 3 v2) and the Tinkercad software were used to design and fabricate the film holders with Polylactic Acid (PLA) filament and 0.4 mm nozzle. EBT3 film sheet was cut into 3x4 cm² (size of the holding space of the film holders) pieces. Films were calibrated (0-10 Gy) on a Truebeam in our institution. In-water PDD (normalized to depth 1 mm from the source surface) and profile measurements were performed with these film sheets irradiated by a Y-90 planar source (6 mm in diameter). In-film PDD curve was also measured using a stack of 18 cut films. Following AAPM TG-235 recommendations², irradiated films were processed and scanned using an Epson-10000XL flat-bed scanner. The dose distribution was then determined from the calibration curve.

RESULTS
Measured printing accuracy was within 0.5 mm. Exponential fit (\( y = A_1 e^{-x/t_1} \)) of the in-water PDD curve yielded a R² of 0.998. In-film PDD curve has a faster dose fall-off due to its higher density. However, after applying a scaling factor of 1.4, the in-film PDD agreed well with the in-water PDD (Correlations Coefficient=0.9993). Profiles were acquired at depths of 0.14, 1.28, 3.28 mm corrected for film thickness. Full-width-half maximum (FWHM), calculated from RT V6.8, were 5.191±0.014, 5.436±0.076, 7.29±0.37 mm, respectively.

CONCLUSION
This is the first experimental study on the dose distribution of the novel Y-90 planar source for ocular melanoma brachytherapy. The 3D-printed film holders demonstrated effectiveness in acquiring PDD and dose profile curves. The in-film measurement is easy to implement but requires a scaling factor of 1.4 for conversion to in-water measurement.

REFERENCE

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