ASTRO'S 67TH ANNUAL MEETING

REDISCOVERING RADIATION MEDICINE AND EXPLORING NEW INDICATIONS

In Vivo Time-Resolved Optical Dosimetry With Line Measurement and Source Tracking for Prostate High-Dose-Rate Brachytherapy

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PURPOSE / OBJECTIVES

Brachytherapy enables highly conformal radiotherapy delivery; however, its accuracy relies on surgical precision and few, if any, in-vivo dosimetry systems are available to verify delivered dose. Previous attempts at in-vivo dosimetry lacked the spatial and temporal resolution necessary to accurately measure transit and dwell times, source position, or deposited dose. To address this, we developed a CMOS camera with endoscopic lens capable of imaging a line scintillator inside a transrectal probe. We hypothesized that a scintillator-based optical dosimetry system within a transrectal probe could accurately measure source position, source speed, dwell times, dose-rate (DR) during HDR brachytherapy, providing in-vivo dose measurements which can fit into current clinical workflows.

MATERIAL & METHODS

A transrectal ultrasound probe was designed and manufactured to house an optical dosimetry system consisting of a Green-600 (Penn-Jersey X-Ray) scintillator, an endoscope, and a CMOS imaging sensor. A water filled phantom was designed simulating a rectal cavity to house the probe with interstitial brachytherapy needles positioned at 15, 10, and 7 millimeters from source center to the visible surface of the scintillator. A treatment using these 3 channels was performed with 6 dwell-positions 1 cm apart with a 5-second dwell time using an Ir-192 source in a clinical afterloader(Varian-Bravos). Recorded video from the treatment was geometrically corrected and analyzed to measure optical intensity at each dwell position, dwell time, and source speed and then compared to the treatment report from the system and the dose profile from the treatment planning system. A scale between optical intensity and dose rate was determined and used to calculate dose at all points of source transit.

RESULTS

Each dwell and transit periods of the treatment were successfully captured and measured. Mean transit speed was measured at 9.7 cm/s, with maximum transit speed to be 23.3 cm/s. Peak dose rate was measured to be 51 cGy/second with 3.8% Error. Position of the source was measured within 3.9 mm standard error. Mean dwell time was 5.22 seconds with 4% standard error.

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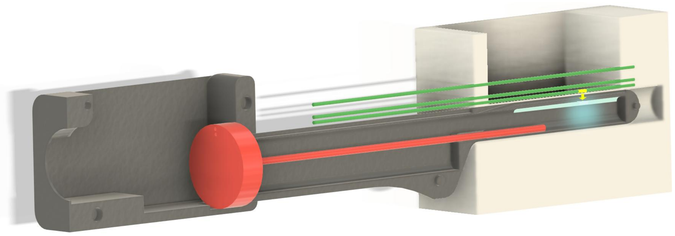
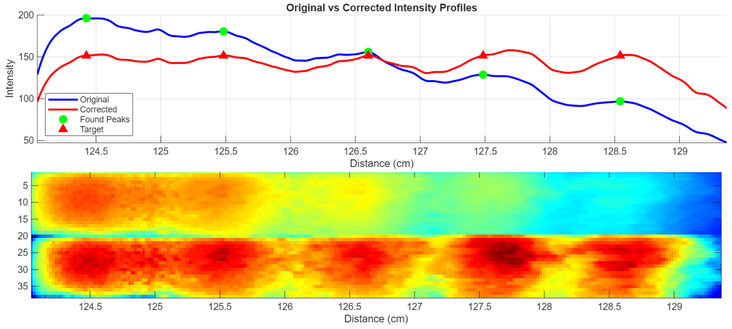
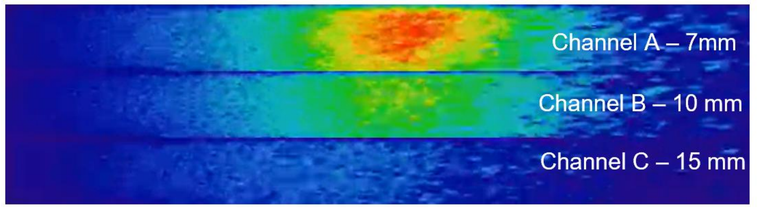
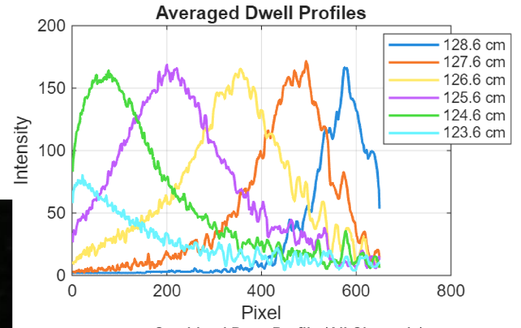
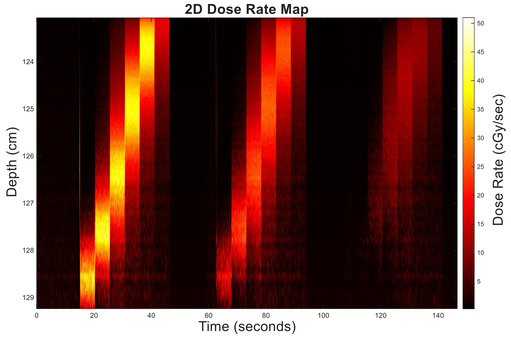


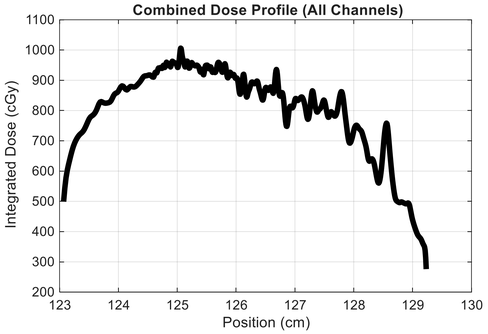


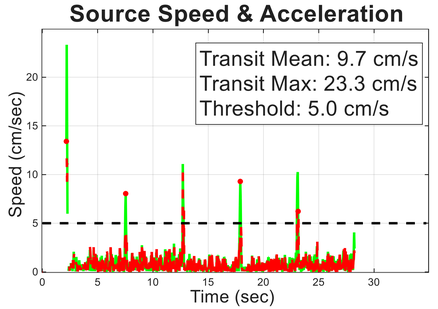


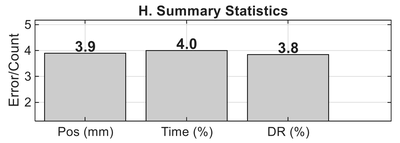
RESULTS

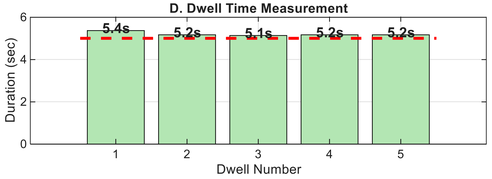












SUMMARY / CONCLUSION

This prototype system shows promise of providing measurements of time and spatially resolved in vivo dosimetry in HDR prostate brachytherapy treatments. The system measures previously unmonitored dose to the anterior rectal wall, provides in-vivo measurements of source position, dwell time, transit speed, and measures the transit doses that are unaccounted for by treatment planning systems.