Validation of radiochromic film for out-of-field dosimetry

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Introduction

Techniques and technology for delivering radiotherapy have evolved over the past several decades. These advances have greatly improved our ability to deliver higher tumor doses while minimizing the dose to the adjacent organs at risk. For photon therapy, this improved conformality has not mitigated the problem of doses to normal tissues outside the treated volume[1]. Regardless of the type of radiotherapy being used, out-of-field doses delivered by photons, electrons, protons, or neutrons pose unique challenges to medical physicists. Quantifying these out-of-field doses is also challenging due to inaccuracies in the treatment planning system's dose calculation algorithms and missing anatomy from the planning computed tomography image set[2]. One solution to accurately quantifying these out-of-field doses is to perform measurements in an anthropomorphic phantom which can readily accommodate radiochromic film. The purpose of this study was to validate radiochromic film for out-field dosimetry.

References

1. Kry SF, Bednarz B, Howell RM, et al. AAPM TG 158: Measurement and calculation of doses outside the treated volume from external-beam radiation therapy. *Medical Physics*. 2017;44(10). doi:10.1002/mp.12462.
2. Wang L, Ding G. SU-E-T-545: The Accuracy of the Out-Of-Field Dose Calculations of a Commercial Treatment Planning System. *Medical Physics*. 2013;40(6Part19):331-331. doi:10.1118/1.4814975.

Figure 1a. Linear accelerator used to deliver 6 MV photon beam

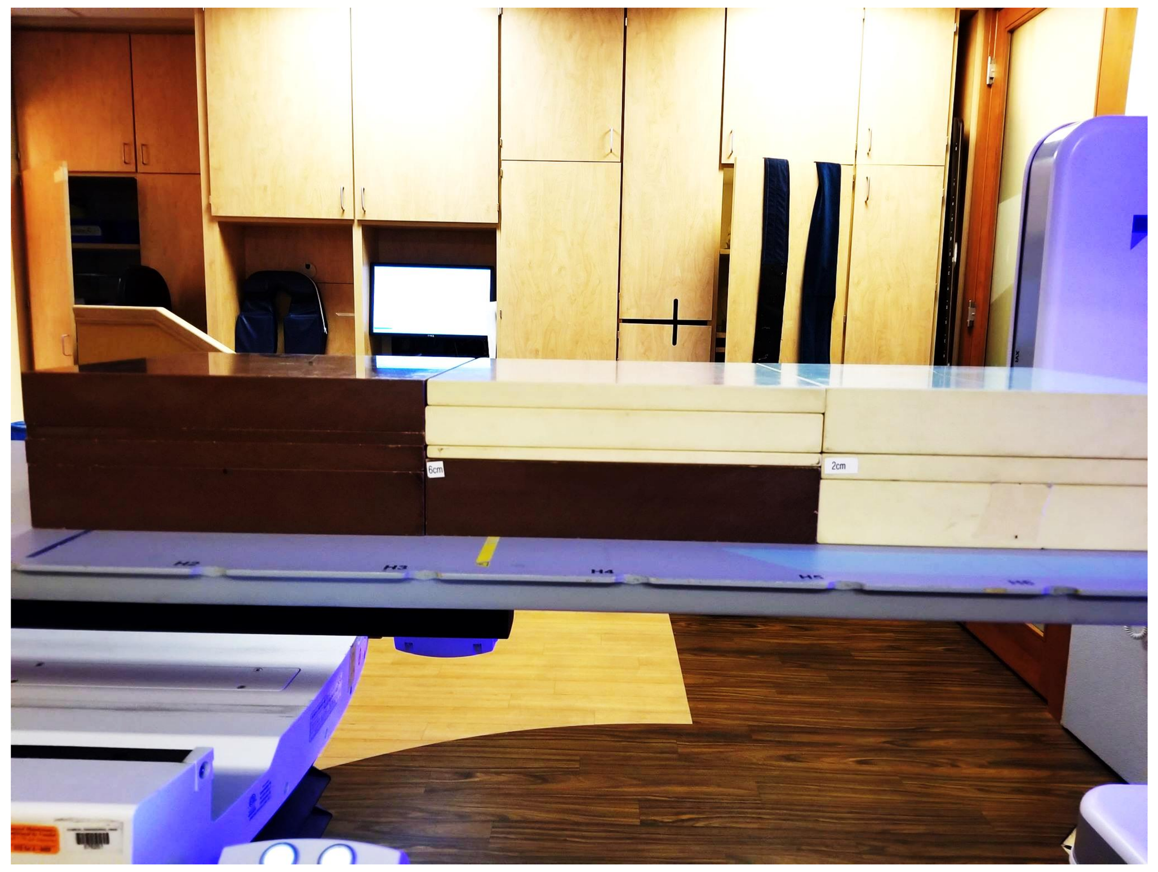

Figure 1b. Solid water phantom set up (6 MV, 10 x10 cm^2, 100 cm SSD)

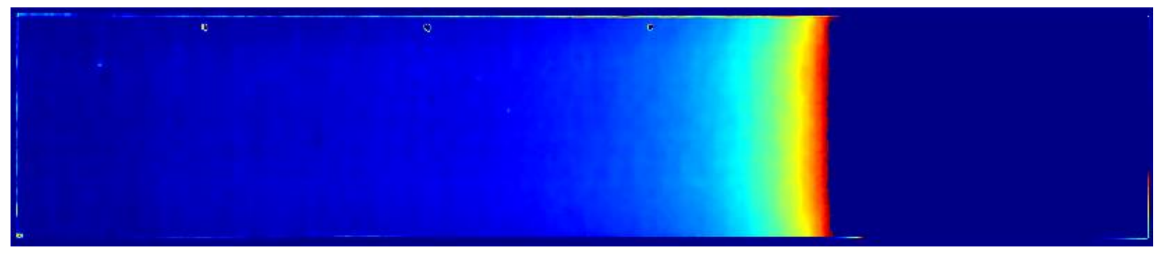

Figure 2a. Processed film #1 with calibration applied for distances of 5-15 cm away from the field edge

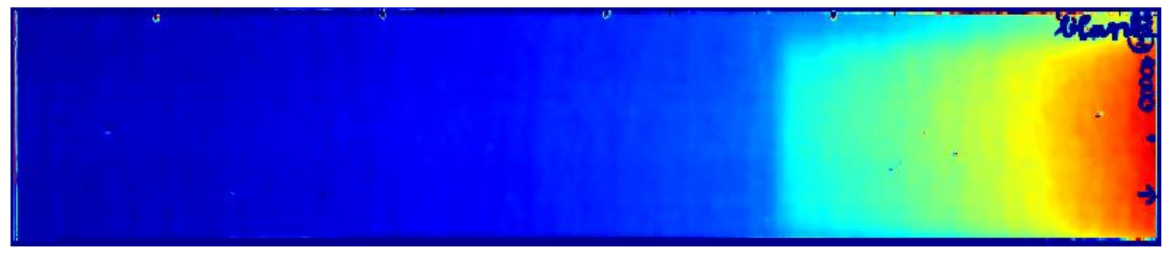

Figure 2b. Processed film #2 with calibration applied for distances of 15-35 cm away from field edge

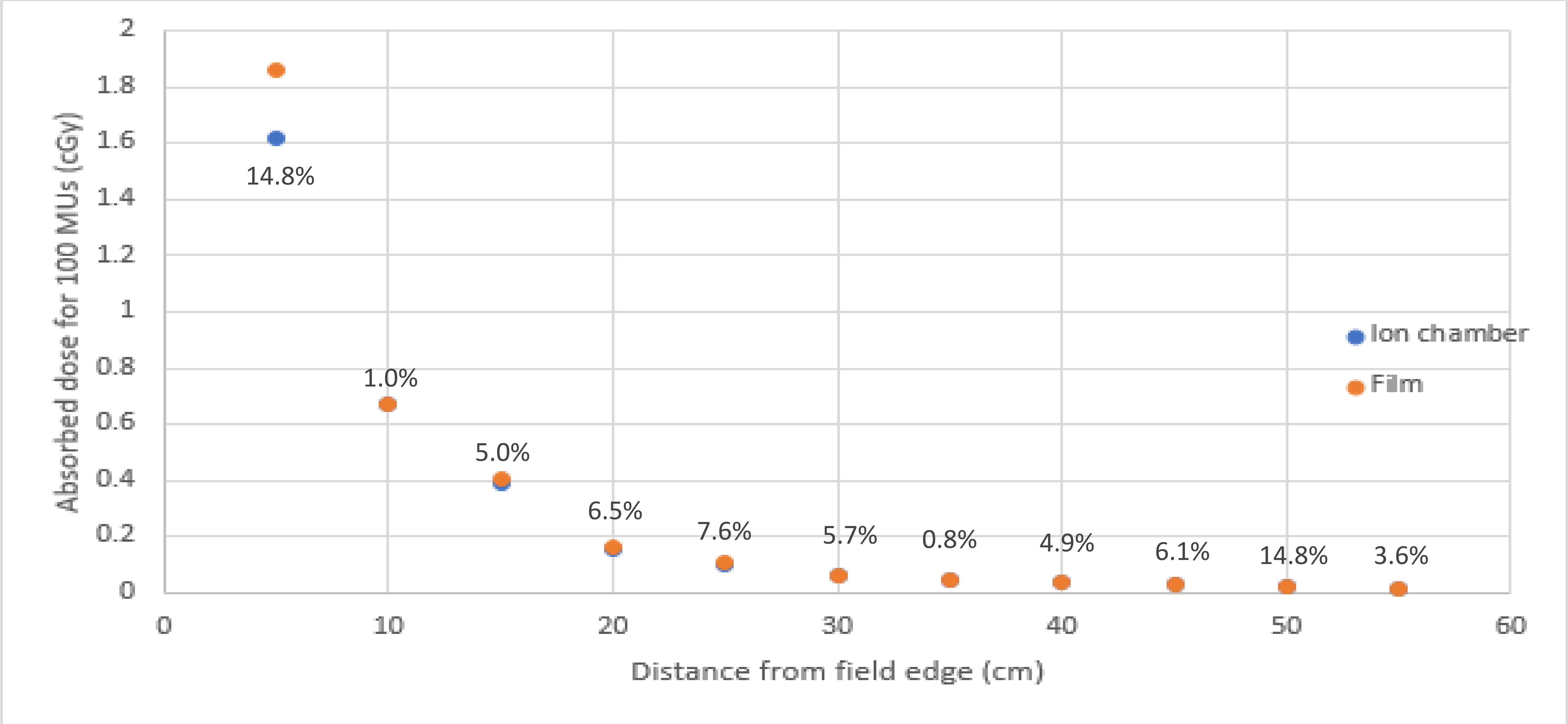

Figure 3. Plotted above is absorbed dose (cGy) for 100 MUs versus distance from the field edge (cm) measured with an ion chamber (blue circles) and film (orange circles). As a figure of merit, the percent difference between the corresponding film and ion chamber measurement is displayed.

Methodology

A solid water phantom was set up to encompass the length of a 10 year-old patient (from the top of the head to the bottom of the pelvis). Reference fields of 6 MV (10x10 cm^2) were delivered to the solid water phantom. Out-of-field measurements were performed with film and a farmer chamber. Results between the two methods were compared and used to evaluate the use of radiochromic film for out-of-field dosimetry with the assumption that the ion chamber is the gold standard.

Result

The average percent difference in absorbed dose between the ion chamber and film measurements was 6.4% with a maximum percent difference of 14.8%.

Discussion

This limited data set, demonstrated the feasibility of using of radiochromic film for out-of-field dosimetry.

Future Studies:

1. Determine the reproducibility of the film
2. Test the implications of dose range and increment for creating the calibration
3. Determine the effects of the total absorbed dose on the accuracy of the film

Conclusion

This study demonstrated the potential use of radiochromic film for out-of-field dosimetry. However, further research is warranted.