The Evaluation of Different Flash Techniques to Improve Robustness in Delivery of IMRT Chestwall Radiation Therapy

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Conclusion

Patient breathing motion and setup discrepancies have long been recognized as factors that increase uncertainties with treatment of the chestwall in the supine position. While advancements in immobilization and treatment techniques are available to reduce chestwall motion (i.e. deep-inspiration-breath-hold), notable differences in in-vivo measured dose versus treatment planned dose are still observed. To correct for this issue, the concept of flash (extended fluence) has been implemented in the design of treatment fields. However, when utilizing beams which incorporate a fluence (such as with IMRT), the integrity of this extended fluence is diminished due to the drastic variation with optimization technique. Moreover, diminishing fluence integrity poses the threat of underdosing superficial targets (i.e. chestwall scar).

This study aims to evaluate optimization techniques to extend fluence outside of the body, as opposed to manual extension, and the subsequent effect noted with introduction of setup variances.

Methods and Materials

Nine (n=9) treatment plans were generated on a chestwall phantom using Eclipse External Beam Planning (Version 15.6). Utilizing the same beam geometry, prescription (standard fractionation of 5000cGy in 25 fractions), and optimization objectives, the dosimetrist generated one treatment plan utilizing flash in the optimization (CW_optiFlash) and one treatment plan in which flash was “painted in” upon completion of the optimization (CW_manFlash).

To further improve robustness with IMRT optimization, each plan was optimized with a scar optimization volume (i.e. _optiScar##) to extend elevated fluence outside of the body in the region of the high risk scar target at 0mm (no extension), 1mm, and 2mm. Final plans were normalized to 95% of the PTV_Scar_EVAL_L receiving 100% prescription dose. All plans were optimized to include nodal volumes to simulate clinical treatments (i.e. sclav, axillia, and IMN).

Each treatment plan was delivered employing the Lungman Chestwall Phantom. A bolus of thickness 0.5 centimeters was placed on top of the high risk scar target to obtain surface dose. In-vivo dosimetry measurements were collected using Optically Stimulated Luminescent Dosimeters (OSLDs) along the scar volume to determine fluence robustness. For comparison purposes, all treatment plans were evaluated against baseline plans having no extended fluence (LNodesCW##_nf).

Finally, all plans were delivered with a 5mm shift in the anterior direction and 5 mm shift in the lateral direction to simulate respiratory motion and setup variance. Shifted plans were ultimately evaluated against the same non-shifted plan to determine clinical robustness of flash.

Average OSL dose measurements (for all plans) fell into a clinically acceptable range for treatment delivery on a non-shifted setup. The introduction of anterior and lateral shifts prompted the greatest change in surface dose delivery among plans without extended fluence (no flash). Robustness in surface dose was not compromised with technique of flash creation (i.e. manual creation versus optimization), nor with scar optimization volume, as all methods of generating flash produced clinically acceptable OSL measurements with the introduction of shifts. More data is needed to further determine statistical significance.

References:

Landauer, microSTAR®ii Medical Dosimetry System and nanoDotsTM. Version 1.0.5018.15489. https://www.landauer.com/microstarii

Introduction

Methods and Materials (continued)

Results

Figure 4b: Fluence Map – G303 CW_optFlash00

Figure 5b: Wedge Setup – Scar

Figure 5c: Bolus Placement – Scar

Figure 6b: Fluence Map – CW_optFlash00

Figure 7b: Fluence Map – CW_manFlash

Figure 8b: Fluence Map – CW_manFlash_0mm

Figure 8c: Fluence Map – CW_optFlash_2mm

For OptFlash plans, an optimization structure (AIRBolusOPTI) was created extending the body 3 cm anteriorly and 3m laterally to the left. The density of this structure was overridden to air. A separate structure (_optiCWAir) was extended into this structure and assigned an objective in the optimizer. For manFlash plans, fluence was painted in upon completion of optimization.

Conclusion

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Acknowledgments

Figure 4a: Fluence Map – L285 CW_manFlash00

Figure 5a: Scar Setup – Scar

Figure 6a: Scar Setup – Scar

Figure 7a: Scar Setup – Scar

Figure 8a: Scar Setup – Scar

Table 1: Average OSL Measurements

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<th>Plan Type</th>
<th>Treatment Field</th>
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Figure 9b: Variation in Surface Dose with Shift in Treatment Delivery

Figure 9c: Variation in Surface Dose with Shift in Treatment Delivery

Table 2: Average OSL Measurements

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Figure 10b: Variation in Surface Dose with Shift in Treatment Delivery

Figure 10c: Variation in Surface Dose with Shift in Treatment Delivery