Validation of a secondary TPS for IROC-H anthropomorphic phantom recalculations

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Introduction

The Imaging and Radiation Oncology Core Houston (IROC-H) has had a long history of verifying an institution's ability to accurately deliver radiation to patients participating in clinical trials. This is primarily accomplished through the anthropomorphic phantoms that an institution irradiates and is measured by IROH-C.

In an effort to improve IROC-H's ability to better detect where a failing institution may have deviation from the expected plan dose distribution, a treatment verification system (TVS) was utilized and benchmarked.

Methods

The treatment verification system used was Mobius3D (Mobius Medical Systems, Houston, TX). The default beam model for 6 MV was altered to more accurately fit IROC-H's reference measurement data. A comparison of the customized beam model and the reference data was then performed for basic dosimetric parameters. A Monte Carlo model of the IROC-H reference data was also used to verify additional parameters. A subset of institution head and neck phantom irradiations was also performed to benchmark the TVS against real world cases.

	PDD 10x10	Jaw Output	MLC output	Off axis
5/6x6/2x2	0.02%	0.06%	-1.01%	-0.11%
10/15x15/3x3	0.01%	-0.12%	-0.26%	0.21%
15/20x20/4x4	0.32%	-0.03%	-0.24%	0.34%
20/30x30/6x6	-0.48%	-0.19%	0.54%	

Table 1. Differences between Mobius3D optimized beam model and IROC-H reference data. Reference data geometry is in units of cm, cm^2, and cm^2, and cm per column respectively.

Field Size	Monte Carlo	Mobius
6x6; F.W. 80/20 Pen.	6.31cm 3.1mm	6.33cm 3.6mm
10x10	10.49cm 3.1mm	10.55cm 3.9mm
20x20	20.96cm 3.3mm	21.05cm 4.2mm

Table 2. Quantitative results of the IROC-H Monte Carlo model and Mobius3D field widths and penumbra widths. Field sizes are in cm^2.
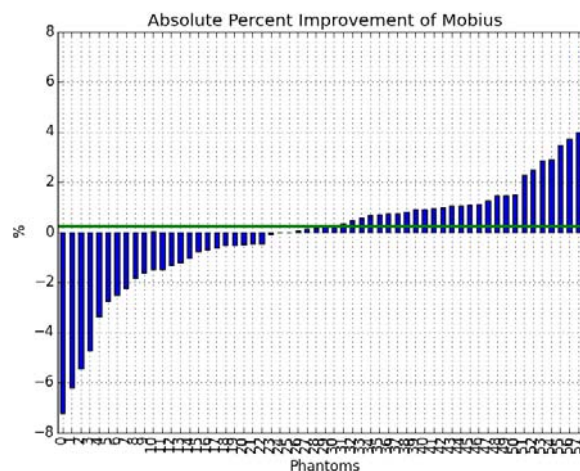

Figure 1. Improvement of measurement-to-plan score using Mobius TVS vs. institution TPS value.

Results

Agreement between the Mobius TVS customized beam model and IROC-H reference beam data is shown in Tables 1 and 2. Agreement was <0.5% for all but two comparison points. Field size comparison showed width and penumbra agreement of <1mm for all field sizes.

Using the Mobius3D TVS to recalculate head and neck phantom plans, the agreement between the measurement and planned value was measured. The improvement in agreement between measurement and planned value using our TVS showed an overall median improvement of 0.22%; i.e. a customized beam model showed better agreement on average than an institution's value.

Values of negative improvement likely signify a highly customized institution beam model, while a positive improvement suggests the institution can improve their beam model.

Conclusions

Customized beam models like the one presented here will be used to recalculate phantoms submitted to IROC-H. The recalculation will be compared to the institution's values. Differences can indicate that the institution may need to reevaluate their treatment planning system. Such a tool gives IROC-H further information to diagnose failures of phantom irradiations.