Validation of the Delta4 Dosimetry Phantom Against Ionometric Measurements

O Calvo1, AN Gutiérrez1, S Stathakis1, P Mavroidis2, S Moral3, C Esquivel1, C Shi1, N Papanikolaou

(1) UT Health Science Center, San Antonio, TX, (2) Karolinska Institutet and Stockholm University, Stockholm, SE, (3) Hospital Universitario de Canarias, La Laguna, ES

Introduction

The semi-measured 3D dose distribution in the cylindrical Delta4 phantom is calculated by using the known planned dose distribution and measurement points along the two orthogonal diode planes. By taking the planned dose and measured dose from the two orthogonal detector-planes, the planned dose along each beam ray is renormalized using the ratio between the planned dose and the measured dose in the intersection point of the ray with the detector plane. The dose is then calculated along all beam rays. The purpose of this study is to independently validate a point dose of the 3D dose calculation methodology used by Delta4 (ScandiDos AB, Uppsala, Sweden) with a calibrated ion chamber.

TomoTherapy Delivery

- DQA plans were created with the Delta4 shifted so that target volumes were placed in the center of the phantom
- Once completed, the plan, the DQA plan, the DQA dose and structures were exported via DICOM RT.
- Delta4 phantom was MVCT for set up accuracy. Necessary shifts were applied and taking the planned dose and measured dose from the two orthogonal detector-planes, the planned dose along each beam ray is renormalized using the ratio between the planned dose and the measured dose corresponding 3D dose distribution calculated by the software. The coordinates of the pinpoint chamber in the intersection point of the ray with the detector plane. The dose is then calculated along all beam rays. The purpose of this study is to independently validate a point dose of the 3D dose calculation methodology used by Delta4 (ScandiDos AB, Uppsala, Sweden) with a calibrated ion chamber.

Results

- Table 1 shows that the chamber agrees with Pinnacle3 within 0.3% to 2%. The 20% scaled dose measurement needs further investigation.
- In the other hand, the table shows that Delta4 overestimates the dose in all the plans while having an increasing improvement going from low doses to high doses with values ranging from -1.81% to -0.058%.
- Table 2 shows the results obtained with the tomotherapy delivery. The table shows good agreement between the chamber and the Delta4 system with percent values ranging from 0.03% to 5.93%. Again the plan for the 20% needs further consideration.

Conclusions

Results show good agreement among the Delta4 measurement, the pinpoint ion chamber measurement, and the planned dose. All high dose measurements for both TomoTherapy and Pinnacle were within 2% agreement. Low dose measurements for both TPS were within +/- 4 Gy. The semi-measured 3D dose calculation methodology appears to be able to accurately predict doses.

Materials and Methods

- Measurements were performed using the TomoTherapy HiArt II system (TomoTherapy, Inc. Madison WI) and Pinnacle Version 8.0m (Philips Medical, Fitchburg WI)/ Varian Clinac 2300 C/D (Varian Medical, Palo Alto CA)
- A pinpoint PTW31006 (PTW, New York City NY) with an active volume of 0.016 cc was used for point dose measurements—see Figure 3
- Delta4 phantom was modified to hold the chamber in one of the four slabs—see Figure 4
- Eight Head and Neck QA plans were created in the two planning systems. Plans were scaled to vary the calculated dose to the pinpoint chamber

Linac Delivery

- Original plan was copied to the Delta4 MVCT phantom images where the chamber point was located, the coordinates identified, and the dose grid defined
- Dose at the chamber point was recorded. Dose and normal tissue contours were exported via DICOM RT to the Delta4™ software. At the moment of delivery of each plan, a point dose measurement was obtained
- Plans ranged from 20% to 160% of the prescribed dose for Pinnacle in increments of 20%

References

1. http://www.scandidos.se/?page_id=3&f=1_2_3

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Tomotherapy HiArt