Magic Gel for Head and Neck IMRT
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Introduction
A redesigned version of the RPC’s IMRT head and neck phantom was developed to incorporate a polymer gel dosimeter. The phantom design revision included converting the currently used imaging/dosimetry insert from a block-style design to a cylindrical design (Figure 1). This insert contains embedded structures that simulate a primary and secondary target volume as well as an organ at risk (OAR). An additional insert was then constructed to house the polymer gel dosimeter. This insert was specially designed using Baranelli plastic. Both the imaging insert and the gel insert had an image registration system incorporated into their construction (figure 2).

Methods and Materials
A commercially available optical computed tomography (OCT) scanner (Figure 3) was commissioned for this project and future RPC work with polymer gel dosimetry. The OCT scanner was used to image polymer gels before and after being irradiated. The pre-irradiation images were subtracted from the post-irradiation images using a pixel by pixel subtraction method. The resultant images had “difference in pixel values” that were directly proportional to the dose received by each given pixel.

IMRT Evaluation
• Phantom imaged with planning insert installed

-PTV1, PTV2, OAR and TLD volumes contoured

-CORUS treatment planning used

-9-field IMRT treatment

-6 MV energy

-TLD used to verify treatment plan

-3 Gel inserts tested for reproducibility evaluation

-6 gel used for gel calibration

-Subtracted ‘raw data’ images converted to dose images

-Measured dose images compared to TPS dose image using DoseLab

-Profile comparisons and planar comparisons performed using two methods

-Absolute comparison with 10% dose / 3 mm DTA criteria

-Relative comparison with 5% dose / 5 mm DTA criteria

IMRT Evaluation

Fig. 4. The RPC is constructed and laser burned to manufacture the MAGIC polymer gel used for this project (DeDeene et al 2001).

Fig. 5. Typical lateral profiles from an absolute comparison between gel measurements and the computed dose distribution. The 2-D dose distribution of the difference image is shown on the left. The red line on these images indicates where the profile was acquired.

Fig. 6. Typical AP profiles from a relative comparison between gel measurements and the computed dose distribution. The 2-D dose distribution images are shown on the left. The red line on these images indicates where the profile was acquired.

Fig. 7. A typical DoseLab image for an absolute comparison between gel measurements and computed dose distributions. The dark blue region indicates pixels that pass the 10% dose / 5 mm DTA criteria. Note that only localized regions and the canister wall artifact fail the criteria. The computed isodose contours appear in red. The white circle indicates the “effective measured” region evaluated.

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Summary
- OCT verified calculated dose distribution
- Measured dose distributions agree with calculated dose distributions
  - Absolute w/in 10% / 5 mm DTA (over 88% of region)
  - Relative w/in 5% / 3 mm DTA (over 97% of region)

Reproducibility between the 3 different gels ± 1.0%
Reproducibility between OCT scans ± 0.8%

Conclusions
Infrastructure for “in house” polymer gel dosimetry has been established at the RPC
- OCT scanner commissioning
- IMRT head and neck phantom w/gel dosimetry
- MAGIC gel inserts are reproducible within 2%
- OCT scanned images are reproducible within 1%

- Absolute gel dosimetry?
  - 10% / 5 mm DTA - not optimal
  - Supports hypothesis? Further work necessary

- Relative gel dosimetry?
  - 5% / 3 mm DTA
  - Supports hypothesis? Yes

References


